This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

GODFREY LOWELL CABOT SCIENCE LIBRAR
of the Harvard College Library

This book is
FRAGILE
and circulates only with permission.
Please handle with care
and consult a staff member
before photocopying.

Thanks for your help in preserving
Harvard's library collections.

REFERENCE BOOK

OF

TABLES AND FORMULAS

FOR

ELECTRIC STREET RAILWAY ENGINEERS.

COMPILED AND ARRANGED

BY

[illegible]

E. A. MERRILL,

Author of "Electric Lighting Specifications."

NEW YORK:
THE W. J. JOHNSTON COMPANY, LTD.,
253 BROADWAY.
1894.

~~V.4976~~
~~108.7~~

Eng 868.94

HARVARD COLLEGE
LIBRARY.

Bowditch fund

Copyright, 1894,
BY
THE W. J. JOHNSTON CO. LTD.,

PREFACE.

IN the following pages it has been the compiler's purpose to collect the principal tables and formulas of which the Electric Street Railway Engineer makes use in his practical, every-day work, and to arrange them in such brief, concise form as shall enable him to refer to any desired one with the least possible inconvenience.

To this end only those tables and formulas in daily use, and which are for the most part complete in themselves, have been inserted. Those referring to subjects which require special research have been purposely excluded, since if it is necessary to consult works of wider scope for the greater part of the required information, it will involve no additional labor to obtain from the same sources all such information, thus leaving this book so much the more concise in form, and therefore more convenient for reference to its particular subjects.

Not being in any sense a text-book, but essen- ally a reference book for engineers, who are miliar with the use of these tables and formulas, explanatory notes and examples have been omitted as superfluous.

While not always following what might be termed the natural order, the tables and formulas do follow a logical order, beginning with the steam plant and passing successively through cars and their equipment, overhead work, track work, and miscellaneous tables and formulas.

A number of the tables and formulas are original, while many others have been modified and extended to adapt them to the conditions imposed in electric street railway work.

The works of Thurston, Clark, Trautwine, Molesworth, Haswell, Munro and Jamieson, Perrine, Wright, Godwin and others have been freely consulted.

CONTENTS.

PAGE

Hyperbolic Logarithms 1
Mean Pressure Ratios 4
Terminal Pressure Ratios 5
Saving of Fuel by Heating Feed-water 5
Factors of Evaporation 6
Properties of Saturated Steam 8
Table of Loss of Heat from Steam-pipes 10
American Coals 11
American Woods 12
Height and Draught Power of Chimneys 12
Sizes of Chimneys with Appropriate Horse-power Boilers 13
Weight per Square Foot Rolled Iron, in Pounds; and Weight of Iron Stacks per Foot Height, and Inch Diameter 14
Brick Lining for Stacks 14
Bricks 15
Brickwork in Foundations and Walls 15
Horse-powers of Iron and Steel Shafts for Given Diameter and Speed 15
Approximate Dimensions Various Styles of Electric Cars 16
Approximate Weights of Trucks 18
Torque and Horse-power 18
Revolutions per Minute at One Mile per Hour 18
Miles per Hour in Feet per Minute and per Second ... 19
Traction 20
Poles 21

CONTENTS.

PAGE
Average Weights of Various Woods.... 21
Dip in Span and Trolley Wire........ 2
Tables of Copper Wire.................................. 24
Resistances Based on Standard Adopted by A. I. E. E. 2
Breaking Weights, Copper and Silicon Bronze Wires..
Weights of Copper and Silicon Bronze Wires........ . 2
Weights of Iron and Steel Wire............ 27
Weights and Tensile Strength E. B. B. Galvanized Telegraph Wire.................... 28
Galvanized Signal Strand. Seven Wires.... 28
Spikes... 2
Spikes per 1000 ft. and per Mile, Single Track, with Four Spikes per Tie....... 2
Joints................................ 29
Weights of Rails......................... 30
Ties per 1000 ft., and per Mile............ 32
Board Feet, Cubic Feet, and Square Feet of Bearing Surface per Tie.................... 32
Middle Ordinates for Chords of 100 ft.... 33
Middle Ordinates for Chords of 10 ft.. 33
Middle Ordinates and Chords for Arc of 30 ft.........
Length of Circular Arcs whose Radius is 1.... 34
Elevation of Outside Rail... 35
Paving.... 36
Excavation 36
Natural Slopes of Earth............................. 36
Cuts and Fills....... 37
Shrinkage of Earth in Embankment.. 38
Increase of Stone in Embankment.................... 38
Average Weight Compact Earths, Rocks, etc.......... 38
Table of Squares, Cubes, Square Roots, Cube Roots, and Reciprocals of Numbers......... 39
Circumferences and Diameters of Circles (Diameters in Units and Eighths)........ 64
Circumferences and Areas of Circles for Diameters in Feet and Inches 75
Feet Expressed in Decimals of a Mile................. 80

CONTENTS.

PAGE

imals of an Inch for each 1-64.................. 80
hes Expressed in Decimals of a Foot 81
sures of Surface................... 84
sures of Length 84
ivalent Values in English and Metric Systems..... 85
asures of Pressure................................ 86
acity of Cylinders................................ 87
ight of Water.... 87
ad and Pressure of Water. 87
ad Required to Overcome Friction in Straight Pipes. 87
lues of *k* for Various Velocities.......... 88
proximate Formula for Velocity of Water in traight, Smooth, Cylindrical Iron Pipes.......... 88
lue of Coefficient *k* 88
ner's Inch........................ 88
ta for Liquid Rheostat............................. 89
garithms of Numbers............................... 90

HYPERBOLIC LOGARITHMS.

From 1.05 to 10, advancing by .05 with average difference for each intervening .01.

No.	Log.	Dif.	No.	Log.	Dif.
0	0	.00976	2.75	1.0116	.0036
1.05	.0468	.0093	2.80	1.0296	.00354
1.10	.0953	.0089	2.85	1.0473	.00348
1.15	.1398	.0085	2.90	1.0647	.00342
1.20	.1823	.00816	2.95	1.0818	.00336
1.25	.2231	.00786	3	1.0986	.0033
1.30	.2624	.00754	3.05	1.1151	.00326
1.35	.3001	.00728	3.10	1.1314	.0032
1.40	.3365	.00702	3.15	1.1474	.00316
1.45	.3716	.00678	3.20	1.1632	.0031
1.50	.4055	.00656	3.25	1.1787	.00304
1.55	.4383	.00634	3.30	1.1939	.00302
1.60	.4700	.00616	3.35	1.2090	.00296
1.65	.5008	.00596	3.40	1.2238	.00292
1.70	.5306	.0058	3.45	1.2384	.00288
1.75	.5596	.00564	3.50	1.2528	.00282
1.80	.5878	.00548	3.55	1.2669	.0028
1.85	.6152	.00534	3.60	1.2809	.00276
1.90	.6419	.00518	3 65	1.2947	.00272
1.95	.6678	.00506	3.70	1.3083	.0027
2	.6931	.00494	3.75	1.3218	.00264
2.05	.7178	.00482	3.80	1.3350	.00262
2.10	.7419	.00472	3.85	1.3481	.00258
2.15	.7655	.0046	3.90	1.3610	.00254
2.20	.7885	.00448	3.95	1.3737	.00252
2.25	.8109	.0044	4	1.3863	.00248
2.30	.8329	.0043	4.05	1.3987	.00246
2.35	.8544	.00425	4.10	1.4110	.00242
2.40	.8755	.00412	4.15	1.4231	.0024
2.45	8961	.00404	4.20	1.4351	.00236
2.50	.9163	.00396	4.25	1.4469	.00234
2.55	.9361	.00388	4.30	1.4586	.00232
2.60	.9555	.00382	4.35	1.4702	.00228
2.65	.9746	.00374	4.40	1.4816	.00226
2.70	.9933	.00366	4.45	1.4929	.00222

HYPERBOLIC LOGARITHMS.—*Continued.*

No.	Log.	Dif.	No.	Log.	Dif.
4.50	1.5041	.0022	6.40	1 8563	.00156
4.55	1.5151	.0022	6.45	1.8041	.00154
4.60	1.5261	.00216	6.50	1.8718	.00154
4.65	1.5369	.00214	6.55	1.8795	.00152
4.70	1.5476	.0021	6.60	1.8871	.0015
4.75	1.5581	.0021	6.65	1.8946	.0015
4.80	1.5686	.00208	6.70	1.9021	.00148
4.85	1.5790	.00204	6.75	1.9095	.00148
4.90	1.5892	.00204	6.80	1.9169	.00146
4.95	1.5994	.002	6.85	1.9242	.00146
5	1.6094	.002	6.90	1.9315	.00144
5.05	1.6194	.00196	6.95	1.9387	.00144
5.10	1.6292	.00196	7	1.9459	.00142
5.15	1.6390	.00194	7.05	1.9530	.00142
5.20	1.6487	.0019	7.10	1.9601	.0014
5.25	1.6582	.0019	7.15	1.9671	.0014
5.30	1.6677	.00188	7.20	1.9741	.00138
5.35	1.6771	.00186	7.25	1.9810	.00138
5.40	1.6864	.00184	7.30	1.9879	.00136
5.45	1.6956	.00182	7.35	1.9947	.00136
5.50	1.7047	.00182	7.40	2.0015	.00134
5.55	1.7138	.0018	7.45	2.0082	.00134
5.60	1.7228	.00178	7.50	2.0149	.00132
5.65	1.7317	.00176	7.55	2.0215	.00132
5.70	1.7405	.00174	7.60	2.0281	.00132
5.75	1.7492	.00174	7.65	2.0347	.0013
5.80	1.7579	.00171	7.70	2.0412	.0013
5.85	1.7664	.00171	7.75	2.0477	.00128
5.90	1.7750	.00168	7.80	2.0541	.00128
5.95	1.7834	.00168	7.85	2.0605	.00128
6	1.7918	.00166	7.90	2.0669	.00126
6.05	1.8001	.00164	7.95	2.0732	.00126
6.10	1.8083	.00164	8	2.0795	.00124
6.15	1.8165	.00161	8.05	2.0857	.00124
6.20	1.8245	.00161	8.10	2.0919	.00122
6.25	1 8326	.00159	8.15	2.0980	.00122
6.30	1.8405	.00159	8.20	2.1041	.00122
6.35	1.8485	.00156	8.25	2.1102	.00122

HYPERBOLIC LOGARITHMS.—*Continued.*

No.	Log.	Dif.	No.	Log.	Dif.
8.30	2.1163	.0012	9.20	2.2192	.00108
8.35	2.1223	.00119	9.25	2.2246	.00108
8.40	2.1282	.00119	9.30	2.2300	.00108
8.45	2.1342	.00118	9.35	2.2354	.00106
8.50	2.1401	.00117	9.40	2.2407	.00106
8.55	2.1459	.00117	9.45	2.2460	.00106
8.60	2.1518	.00116	9.50	2.2513	.00105
8.65	2.1576	.00115	9.55	2.2565	.00105
8.70	2.1633	.00115	9.60	2.2618	.00104
8.75	2.1691	.00114	9.65	2.2670	.00103
8.80	2.1748	.00113	9.70	2.2721	.00103
8.85	2.1804	.00113	9.75	2.2773	.00102
8.90	2.1861	.00112	9.80	2.2824	.00102
8.95	2.1917	.00111	9.85	2.2875	.00101
9	2.1972	.00111	9.90	2.2925	.00101
9.05	2.2028	.0011	9.95	2.2976	.001
9.10	2.2083	.0011	10	2.3026	
9.15	2.2138	.00108			

MEAN PRESSURE RATIOS.

% Cl'r'nce	0		1.75		3		5		7		9	
Cut-off.	Actual Expansion Ratio.	Mean Pressure Ratio.	Actual Expansion Ratio.	Mean Pressure Ratio.	Actual Expansion Ratio.	Mean Pressure Ratio.	Actual Expansion Ratio.	Mean Pressure Ratio.	Actual Expansion Ratio.	Mean Pressure Ratio.	Actual Expansion Ratio.	Mean Pressure Ratio.
$\frac{1}{10}$	10	.3302	8.659	.3536	7.923	.3691	7	.3919	6.294	.4127	5.737	.4319
$\frac{1}{8}$	8	.3849	7.14	.4050	6.645	.4185	6.	.4385	5.487	.4569	5.069	.4739
$\frac{1}{6}$	6	.4653	5.525	.4814	5.237	.4921	4.846	.5086	4.521	.5237	4.246	.5378
$\frac{1}{5}$	5	.5219	4.678	.5355	4.478	.5448	4.2	.5588	3.963	.5718	3.758	.5839
$\frac{1}{4}$	4	.5966	3.803	.6073	3.678	.6146	3.5	.6258	3.343	.6362	3.206	.6461
$\frac{5}{16}$	3.2	.676	3.083	.6840	3.007	.6895	2.896	.6979	2.797	.7059	2.708	.7134
$\frac{1}{3}$	3	.6995	2.902	.7071	2.835	.7127	2.739	.7195	2.653	.7268	2.574	.7336
$\frac{3}{8}$	5.666	.7425	2.592	.7488	2.543	.7530	2.47	.7592	2.404	.7653	2.344	.7711
$\frac{2}{5}$	2.5	.7665	2.437	.7713	2.395	.7755	2.333	.7812	2.276	.7865	2.224	.7916
$\frac{7}{16}$	2.285	.7993	2.236	.8036	2.203	.8067	2.154	.8116	2.108	.8189	2.066	.8205
$\frac{1}{2}$	2	.8465	1.966	.8498	1.943	.8520	1.909	.8556	1.877	.8584	1.847	.8620
$\frac{5}{8}$	1.6	.9188	1.583	.9201	1.572	.9213	1.555	.9230	1.539	.9246	1.524	.9262
$\frac{3}{4}$	1.333	.9658	1.325	.9660	1.320	.9662	1.312	.9672	1.305	.9682	1.297	.9691
$\frac{4}{5}$	1.25	.9784	1.244	.9785	1.240	.9786	1.235	.9794	1.23	.9801	1.225	.9806
$\frac{9}{10}$	1.111	.9947	1.109	.9948	1.107	.9949	1.105	.9950	1.103	.9951	1.101	.9952

To find the mean pressure exerted throughout the stroke, multiply the absolute initial pressure (above a vacuum) by the number opposite the given cut-off and in the column corresponding to the percentage of clearance, and deduct the absolute back pressure. The result will be about 5 per cent. higher than the probable actual mean pressure.

TERMINAL PRESSURE RATIOS.

% Clearance.	0	1.75	3	5	7	9
Cut-off.	Ratio.	Ratio.	Ratio.	Ratio.	Ratio	Ratio
1/10	.1	.1155	.1262	.1428	.1589	.1743
1/8	.1251	.14	.1504	.1666	.1822	.1972
1/6	.1666	.1809	.1909	.2063	.2211	.2354
1/5	.2	.2137	.2233	.2381	.2523	.2660
1/4	.25	.2629	.2718	.2857	.2990	.3119
5/16	.3125	.3243	.3325	.3452	.3575	.3692
1/3	.3333	.3445	.3527	.3651	.3769	.3883
3/8	.375	.3858	.3819	.4048	.4159	.4266
2/5	.4	.4103	.4174	.4285	.4392	.4495
7/16	.4375	.4472	.4539	.4643	.4743	.4839
1/2	.5	.5086	.5145	.5238	.5327	.5413
5/8	.625	.6317	.6359	.6428	.6495	.6559
3/4	.75	.7543	.7555	.7619	.7663	.7706
4/5	.8	.8038	.8058	.8095	.8130	.8163
9/10	.9	.9017	.9029	.9047	.9065	.9082

To find the (theoretical) absolute terminal pressure, multiply the absolute initial pressure by the number opposite the given cut-off and in the column corresponding to the percentage of clearance.

SAVING OF FUEL BY HEATING FEED WATER.

In per cent. Steam at 100 lbs. gauge pressure.

Final Temperature Feed Water, F.	Initial Temperature Feed Water in Degrees F.				
	50	60	70	125	210
125	6.44	5.62	4.81		
210	13.76	13.01	12.26	7.83	
250	17.19	16.48	15.74	11.5	3.98
300	21.49	20.81	20.12	16 1	8.97

The variation between 70 lbs. and 150 lbs. gauge pressure is practically negligible compared with the above.

FACTORS OF

For equivalent evapora

Temperature of Feed Water in Degrees.		Gauge Pressure of Steam, in Lbs. per Sq. In.								
		25	35	45	55	65	75	85	95	105
F.	C.									
32	0	1.204	1.209	1.212	1.216	1.218	1.221	1.223	1.226	1.228
35	1.6	1.201	1.206	1.209	1.213	1.215	1.218	1.220	1.223	1.225
40	4.4	1.196	1.201	1.204	1.208	1.210	1.213	1.215	1.218	1.220
45	7.2	1.190	1.195	1.198	1.202	1.204	1.207	1.209	1.212	1.214
50	10	1.185	1.190	1.193	1.197	1.199	1.202	1.204	1.207	1.209
55	12.7	1.180	1.185	1.188	1.192	1.194	1.197	1.199	1.202	1.204
60	15.5	1.175	1.180	1.183	1.187	1.189	1.192	1.194	1.197	1.199
65	18.3	1.170	1.175	1.178	1.182	1.184	1.187	1.189	1.192	1.194
70	21.1	1.165	1.170	1.173	1.177	1.179	1.182	1.184	1.187	1.189
75	23.9	1.160	1.165	1.168	1.172	1.174	1.177	1.179	1.182	1.184
80	26.6	1.154	1.159	1.162	1.166	1.168	1.171	1.173	1.176	1.178
85	29.4	1.149	1.154	1.157	1.161	1.163	1.166	1.168	1.171	1.173
90	32.2	1.144	1.149	1.152	1.156	1.158	1.161	1.163	1.166	1.168
95	35	1.139	1.144	1.147	1.151	1.153	1.156	1.158	1.161	1.163
100	37.7	1.134	1.139	1.142	1.146	1.148	1.151	1.153	1.156	1.158
105	40.5	1.128	1.133	1.136	1.140	1.142	1.145	1.147	1.150	1.152
110	43.3	1.123	1.128	1.131	1.135	1.137	1.140	1.142	1.145	1.147
115	46.1	1.118	1.123	1.126	1.130	1.132	1.135	1.137	1.140	1.142
120	48.8	1.113	1.118	1.121	1.125	1.127	1.130	1.132	1.135	1.137
125	51.6	1.108	1.113	1.116	1.120	1.122	1.125	1.127	1.130	1.132
130	54.4	1.102	1.107	1.110	1.114	1.116	1.119	1.121	1.124	1.126
135	57.2	1.097	1.102	1.105	1.109	1.111	1.114	1.116	1.119	1.121
140	60	1.092	1.097	1.100	1.104	1.106	1.109	1.111	1.114	1.116
145	62.7	1.087	1.092	1.095	1.099	1.101	1.104	1.106	1.109	1.111
150	65.5	1.082	1.087	1.090	1.094	1.096	1.099	1.101	1.104	1.106
155	68.3	1.076	1.081	1.084	1.088	1.090	1.093	1.095	1.098	1.100
160	71.1	1.071	1.076	1.079	1.083	1.085	1.088	1.090	1.093	1.095
165	73.8	1.066	1.071	1.074	1,078	1.080	1.083	1.085	1.088	1.090
170	76.6	1.061	1.066	1.069	1.073	1.075	1.078	1.080	1.083	1.085
175	79.4	1.056	1.061	1.064	1.068	1.070	1.073	1.075	1.078	1.080
180	82.2	1.050	1.055	1.058	1.062	1.064	1.067	1.069	1.072	1.074
185	85	1.045	1.050	1.053	1.057	1.059	1.062	1.064	1.067	1.069
190	87.7	1.040	1.045	1.048	1.052	1.054	1.057	1.059	1.062	1.064
195	90.5	1.035	1.040	1 043	1.047	1.049	1.052	1.054	1.057	1.059
200	93.3	1.030	1.035	1.038	1.042	1.044	1.047	1.049	1.052	1.054
205	96.1	1.024	1.029	1.032	1.036	1.038	1.041	1.043	1.046	1.048
210	98 8	1.019	1.024	1.027	1.031	1.033	1.036	1.038	1.041	1.043
212	100	1.017	1.022	1.025	1.029	1.031	1.034	1.036	1.039	1.041

The factors of evaporation for equivalent evaporation pressure may be obtained by multiplying the above

EVAPORATION.

tion from and at 212° F.

Temperature of Feed Water in Degrees.		Gauge-pressure of Steam, in Lbs. per Sq. In.								
F.	C.	115	125	135	145	155	165	175	185	200
32	0	1.230	1.231	1.233	1.235	1.236	1.238	1.239	1.240	1.241
35	1.6	1.227	1.228	1.230	1.232	1.243	1.235	1.236	1.237	1.238
40	4.4	1.222	1.223	1.225	1.227	1.228	1.230	1.231	1.232	1.233
45	7.2	1.216	1.217	1.219	1.221	1.222	1.224	1.225	1.226	1.226
50	10	1.211	1.212	1.214	1.216	1.217	1.219	1.220	1.221	1.222
55	12.7	1.206	1.207	1.209	1.211	1.212	1.214	1.215	1.216	1.217
60	15.5	1.201	1.202	1.204	1.206	1.207	1.209	1.210	1.211	1.212
65	18.3	1.196	1.197	1.199	1.201	1.202	1.204	1.205	1.206	1.207
70	21.1	1.191	1.192	1.194	1.196	1.197	1.199	1.200	1.201	1.202
75	23.9	1.186	1.187	1.189	1.191	1.192	1.194	1.195	1.196	1.197
80	26.6	1.180	1.181	1.183	1.185	1.186	1.188	1.189	1.190	1.191
85	29.4	1.175	1.176	1.178	1.180	1.181	1.183	1.184	1.185	1.186
90	32.2	1.170	1.171	1.173	1.175	1.176	1.178	1.179	1.180	1.181
95	35	1.165	1.166	1.168	1.170	1.171	1.173	1.174	1.175	1.176
100	37.7	1.160	1.161	1.163	1.165	1.166	1.168	1.169	1.170	1.171
.105	40.5	1.154	1.155	1.157	1.159	1.160	1.162	1.163	1.164	1.165
110	43.3	1.149	1.150	1.152	1.154	1.155	1.157	1.158	1.159	1.160
115	46.1	1.144	1.145	1.147	1.149	1.150	1.152	1.153	1.154	1.155
120	48.8	1.139	1.140	1.142	1.144	1.145	1.147	1.148	1.149	1.150
125	51.6	1.134	1.135	1.137	1.139	1.140	1.142	1.143	1.144	1.145
130	54.4	1.128	1.129	1.131	1.133	1.134	1.136	1.137	1.138	1.139
135	57.2	1.123	1.124	1.126	1.128	1.129	1.131	1.132	1.133	1.134
140	60	1.118	1.119	1.121	1.123	1.124	1.126	1.127	1.128	1.129
145	62.7	1.113	1.114	1.116	1.118	1.119	1.121	1.122	1.123	1.124
150	65.5	1.108	1.109	1.111	1.113	1.114	1.116	1.117	1.118	1.119
155	68.3	1.102	1.103	1.105	1.107	1.108	1.110	1.111	1.112	1.113
160	71.1	1.097	1.098	1.100	1.102	1.103	1.105	1.106	1.107	1.108
165	73.8	1.092	1.093	1.095	1.097	1.098	1.100	1.101	1.102	1.103
170	76.6	1.087	1.088	1.090	1.092	1.093	1.095	1.096	1.097	1.198
175	79.4	1.082	1.083	1.085	1.087	1.088	1.090	1.091	1.092	1.093
180	82.2	1.076	1.077	1.079	1.081	1.082	1.084	1.085	1.086	1.087
185	85	1.071	1.073	1.074	1.076	1.077	1.079	1.080	1.081	1.082
190	87.7	1.066	1.067	1.069	1.071	1.072	1.074	1.075	1.076	1.077
195	90.5	1.061	1.062	1.064	1.066	1.067	1.069	1.070	1.071	1.072
200	93.3	1.056	1.057	1.059	1.061	1.062	1.064	1.065	1.066	1.067
205	96.1	1.050	1.051	1.053	1.055	1.056	1.058	1.059	1.060	1.062
210	98.8	1.045	1.046	1.048	1.050	1.051	1.053	1.054	1.055	1.057
212	100	1.043	1.044	1.046	1.048	1.049	1.051	1.052	1.053	1.055

from feed water at 100° F. to steam at 70 lbs. gauge factors by .8703.

PROPERTIES OF SATURATED STEAM.

Pressure above Vacuum. Lbs. per Sq. In.	Temperature. Degrees F.	Quantities of Heat, B.T.U.			Weight in Lbs. of Cu. Ft. Steam.	Volume.		Pressure above Vacuum. Lbs. per Sq. In.
		To Raise Temperature of Water from 32° to T°.	Latent Heat of Evaporation.	Total Heat of Evaporation above 32°.		Of Pound of Steam in Cu. Ft.	Ratio Vol. Steam to Vol. Equal Wt. Water at Max. Density	
20	227.964	196.655	954.814	1151.469	.050696	19.73	1231.0	20
25	240.053	208.887	946.270	1155.157	.062524	16.00	998.4	25
30	250.293	219.261	939.019	1158.280	.074201	13.48	841.3	30
35	259.221	228.316	932.687	1161.003	.085766	11.66	727.9	35
40	267.168	236.386	927.040	1163.426	.097231	10.28	642.0	40
45	274.347	242.275	921.935	1165.615	.108616	9.207	574.7	45
50	280.904	250.355	917.260	1167.615	.119927	8.338	520.5	50
55	286.955	256.518	912.942	1169.460	.131172	7.624	475.9	55
60	292.575	262.248	908.928	1171.176	.142362	7.024	438.5	60
65	297.830	267.612	905.167	1172.779	.153500	6.515	406.6	65
70	302.774	272.657	901.629	1174.286	.164584	6.076	379.3	70
72	304.669	274.597	900.269	1174.866	.169003	5.917	369.4	72
75	307.440	277.427	898.283	1175.710	.175622	5.694	355.5	75
77	309.239	279.265	896.994	1176.259	.180027	5.555	346.8	77
80	311.866	281.952	895.108	1177.060	.186627	5.358	334.5	80

82	313.576	283.701	893.879	1177.580	.191017	5.235	326.8	82
85	316.076	286.260	892.088	1178.348	.197591	5.061	315.9	85
87	317.705	287.927	890.913	1178.840	.201969	4.951	309.1	87
90	320.094	290.373	889.196	1179.569	.208525	4.796	299.4	90
92	321.653	291.970	888.075	1180.045	.212892	4.697	293.2	92
95	323.939	294.314	886.427	1180.741	.219430	4.557	284.5	95
97	325.431	295.845	885.352	1181.197	.223778	4.469	279.0	97
100	327.625	298.093	883.773	1181.866	.230293	4.342	271.1	100
102	329.060	299.566	882.737	1182.303	.234464	4.262	266.0	102
105	331.169	301.731	881 214	1182.945	.241189	4.147	258.9	105
107	332.550	303.152	880.214	1183.366	.245467	4.074	254.3	107
110	334.582	305.242	878.744	1183.986	.251947	3.969	247.8	110
112	335.914	306.609	877.784	1184.393	.256263	3 902	243.6	112
115	337.874	308.621	876.371	1184.992	.262732	3.806	237.6	115
117	339.159	309.939	875.444	1185.383	.267041	3.745	233.8	117
120	341.058	311.885	874 076	1185.961	.273500	3.656	228.3	120
125	344.136	315.051	871.848	1186.899	.284248	3.518	219.6	125
130	347.121	318.121	869.688	1187.809	.294961	3.390	211.6	130
135	350.015	321.105	867.590	1188.695	.305659	3.272	204.2	135
140	352.827	324.003	865.552	1189.555	.316338	3.161	197.3	140
145	355.562	326.823	863.567	1190.390	.326998	3.058	190.9	145
150	358.223	329.566	861.634	1191.200	.337643	2.962	184.9	150
160	363.346	334.850	857.912	1192.762	.358886	2.786	173.9	160
170	368.226	339.892	854.359	1194.251	.380071	2.631	164.3	170
180	372.886	344.708	850.963	1195.671	.401201	2.493	155.6	180
190	377.352	349.329	847.703	1197.032	.422280	2.368	147.8	190
200	381.636	353.766	844.573	1198.339	.443310	2.256	140.8	200

TABLE OF LOSS OF HEAT FROM STEAM PIPES.

Thickness of Covering in Inches.	Outside Diameter of Pipe, Without Felt.														
	2 in. Diameter.			4 in. Diameter.			6 in. Diameter.			8 in. Diameter.			12 in. Diameter.		
	Loss in Units per Foot Run per Hour.	Ratio of Loss.	Feet in Length per H.P. Lost.	Loss in Units per Foot Run per Hour.	Ratio of Loss.	Feet in Length per H.P. Lost.	Loss in Units per Foot Run per Hour.	Ratio of Loss.	Feet in Length per H.P. Lost.	Loss in Units per Foot Run per Hour.	Ratio of Loss.	Feet in Length per H.P. Lost.	Loss in Units per Foot Run per Hour.	Ratio of Loss.	Feet in Length per H.P. Lost.
0	219.0	1.00	132	390.8	1.00	75	624.1	1.000	46	729.8	1.000	40	1077.4	1.000	26
¼	100.7	.46	288	180.9	.46	160									
½	65.7	.30	441	117.2	.30	247	187.2	.300	154	219.6	.301	132	301.7	.280	92
1	43.8	.20	662	73.9	.18	892	111.0	.178	261	128.8	.176	225	185.3	.172	157
2	28.4	.13	1020	44.7	.11	648	66.2	.106	438	75.2	.103	385	98.0	.091	294
4	19.8	.09	1464	28.1	.07	1031	41.2	.066	703	46.0	.063	630	60.8	.056	486
6				23.4	.06	1238	33.7	.054	860	34.3	.047	845	45.2	.042	642

1 H. P. assumed equivalent to about 29,000 units.

AMERICAN COALS.

Coal. State.	Coal. Kind of Coal.	Per Cent of Ash.	Theoretical Value. In Heat Units.	Theoretical Value. Pounds of Water Evap.
Penn.	Anthracite..........	3.49	14,199	14.70
"	"	6.18	13,535	14.01
"	"	2.90	14,221	14.72
"	Cannel....	15.02	13,143	13.60
"	Connellsville........	6.50	13,368	13.84
"	Semi-bituminous...	10.70	13,155	13.62
"	Stone's Gas.........	5.00	14,021	14.51
"	Youghiogheny......	5.60	14,265	14.76
"	Brown..............	9.50	12,824	12.75
Kentucky.	Coking.........	2.75	14,391	14.89
"	Cannel.........	2.00	15,198	16.76
"	"	14.80	13,360	13.84
"	Lignite.........	7.00	9,326	9.65
Illinois.	Bureau Co.......	5.20	13,025	13.48
"	Mercer Co.......	5.60	13,123	13.58
"	Montauk.........	5.50	12,659	13.10
Indiana.	Block...........	2.50	13,588	14.38
"	Coking..........	5.66	14,146	14.64
"	Cannel..........	6.00	13,097	13.56
Maryland.	Cumberland..	13.88	12,226	12.65
Arkansas.	Lignite	5.00	9,215	9.54
Colorado.	"	9.25	13,562	14.04
"	"	4.50	13,866	14.35
Texas.	"	4.50	12,962	13.41
Washington Ter.	Lignite..	8.40	11,551	11.96
Pennsylvania.	Petroleum	....	20,746	21.47

The weight of solid coal varies from 80 lbs. to 100 lbs. per cubic foot.

The weight of heaped coal varies from 45 lbs. to 56 lbs. per cubic foot.

The bulk of one ton of heaped coal varies from 50 to 40 cubic feet.

AMERICAN WOODS.

Kind of Wood.	Weight per Cord.	Value in Tons Coal.	
		Anthracite.	Bituminous
Hickory—Shell-bark	4469	.608	.563
White oak	3821	.52	.481
Hickory—Red-heart	3705	.504	.467
Southern pine	3375	.459	.425
Red oak	3254	.443	.41
Beech	3126	.425	.394
Hard maple	2878	.391	.363
Virginia pine	2680	.364	.338
Spruce	2325	.316	.293
New Jersey pine	2137	.291	.269
Yellow "	1904	.259	.24
White "	1868	.254	.235

HEIGHT AND DRAUGHT POWER OF CHIMNEYS.

Height of Chimney in Feet.	Draught Power in Inches of Water.	Height of Chimney in Feet.	Draught Power in Inches of Water.
10	.073	80	.585
20	.146	90	.657
30	.219	100	.730
40	.292	120	.876
50	.365	150	1.095
60	.438	175	1.277
70	.511	200	1.460

SIZES OF CHIMNEYS WITH APPROPRIATE HORSE-POWER BOILERS.

Diameter in Inches.	Height of Chimneys.											Effective Area. Square Ft.	Actual Area. Square Ft.	Side of Square of Approximate Area. Inches.
	50 ft.	60 ft.	70 ft.	80 ft.	90 ft.	100 ft.	110 ft.	125 ft.	150 ft.	175 ft.	200 ft.			
	Commercial Horse-power.													
18	23	25	27									0.97	1.77	16
21	35	38	41									1.47	2.41	19
24	49	54	58	62								2.08	3.14	22
27	65	72	78	83								2.78	3.98	24
30	84	92	100	107	113							3.58	4.91	27
33		115	125	133	141							4.47	5.94	29
36		141	152	163	178	182						5.47	7.07	32
39			183	196	208	219						6.57	8.30	35
42			216	231	245	258	271					7.76	9.62	37
48				311	330	348	365	389				10.44	12.57	43
54				363	427	449	472	503	551			13.51	15.90	48
60				505	539	565	593	632	692	748		16.98	19.64	53
66					658	694	728	776	849	918	981	20.83	23.76	59
72					792	835	876	934	1023	1105	1181	25.08	28.27	64
78						995	1038	1107	1212	1310	1400	29.73	33.18	69
84						1163	1214	1294	1418	1531	1637	34.76	38.48	75
90						1344	1415	1496	1639	1770	1893	40.19	44.18	80
96						1537	1616	1720	1876	2027	2167	46.01	50.27	85

WEIGHT PER SQUARE FOOT ROLLED IRON, IN POUNDS; AND WEIGHT OF IRON STACKS PER FOOT HEIGHT AND INCH DIAMETER.

(10 per cent added for overlap and rivets.)
For steel add 1-48th.

Number B.W.G.	Size in Fractions Inch.	Thickness in Decimals Inch.	Weight per Square Foot.	Weight Stack per Foot Height and Inch Diameter
	⅜	.375	15.	4.32
0		.340	13.7	3.945
	5-16	.3125	12.5	3.6
1		.300	12.1	3.484
2		.284	11.4	3.283
3		.259	10.4	2.995
	¼	.250	10.	2.88
4		.238	9.6	2.764
5		.220	8.85	2.548
6		.203	8.17	2.352
	3-16	.187	7.5	2.16
7		.180	7.24	2.085
8		.165	6.65	1.915
9		.148	5.96	1.716
10		.134	5.40	1.555
	⅛	.125	5.	1.44
11		.120	4.83	1.391
12		.109	4.40	1.267
14		.083	3.34	.962
16		.065	2.62	.754
	1-16	.062	2.5	.72
18		.049	1.97	.567

BRICK LINING FOR STACKS.

Allowing 1½″ air space between stack and lining:
Bricks 8¼″ × 4″ × 2″, laid without mortar;
Lining 8¼″ (one brick) thick;
Number of bricks per foot in diameter of stack and per foot of height = 47.
Allowing 1″ air space between stack and lining:
Bricks 8¼″ × 4″ × 2″, laid without mortar;
Lining 4″ (one brick) thick;
Number of bricks per foot in diameter of stack and per foot of height = 25.

BRICKS.

The following table gives the usual dimensions of the bricks of some of the principal makers :

Description.	Inches.	Description.	Inches.
Baltimore front...	8¼×4⅛×2⅜	Maine........	7½×3⅜×2⅜
Philadelphia front		Milwaukee...	8½×4⅛×2⅜
Wilmington front.		North River..	8 ×3½×2¼
Trenton front.....		Trenton......	8 ×4 ×2¼
Croton............	8¼×4 ×2¼	Ordinary	7¾×3⅝×2¼ 8 ×4⅛×2¼
Colabaugh........	8¼×3⅝×2⅜		

FIREBRICK.

Valentine's (Woodbridge, N. J.)........	8¾ × 4⅝ × 2½ in.
Downing's (Allentown, Pa.)............	9 × 4⅝ × 2⅜ "

WEIGHTS PER CUBIC FOOT. IN POUNDS.

Best pressed brick........................	150
Common hard "	125
" brick...................... ...	112
Soft brick....	100
Fine "	137

BRICKWORK IN FOUNDATIONS AND WALLS.

Based on following dimensions : 8¼ × 4 × 2.

Thickness of Joints in Inches.	Proportion of Mortar to Whole Mass. %	Bricks per Cubic Foot.	Bricks per Superficial Foot and Inch of Thickness.
⅛	10.8	23.5	1.8
¼	20.8	20.7	1.72
⅜	29.2	18.5	1.54
½	36.4	16.6	1.39
⅝	42.8	14.9	1.25

HORSE-POWERS OF IRON AND STEEL SHAFTS FOR GIVEN DIAMETER AND SPEED.

Head shafts, or those subjected to extra strains................................H.P. $= \frac{D^3R}{125}$

Line shafts....... ........................H.P. $= \frac{D^3R}{100}$

Counter shafts.......... ....................H.P. $= \frac{D^3R}{80}$

D = diameter in inches.
R = revolutions per minute.

APPROXIMATE DIMENSIONS VARIOUS STYLES OF ELECTRIC CARS.

MOTOR CARS.

Kind.	Length over Platforms.	Length over Posts.	Length of Platforms.	Height over All.	Size of Wheels.	Height Inside.	Width.	Number of Seats.	Kind of Seats.	Seating Capacity.	Weight of Body. lbs.
Closed....	24′	16′	4′	10′ 6″ to 11′	33″ to 36″	7′ 8″ to 8′	7′6″	2	Length of car	22	4500 to 5000
"	26′	18′	4′	"	"	"	"	2	"	26	4800 to 5100
"	32′	24′	4′	"	"	"	"	2	"	34	6000
Convertible summer and winter.	33′ 6″	25′ 6″	4′	"	"	"	7′ 10″	2	"	40	6200
Combination open and closed.	29′	11′ 8″	......	"	"	"	7′ 6″	....	....	open part 24 closed part 16	5500
Open, but closed ends.	26′	20′ 8″	2′ 8″	"	"	"	6′ 10″	8	reversible	40	4400
Open, and open ends..	22′ 6″	.....	......	"	"	"	"	7	"	35	3500
" " " " ..	30′ 9″	.....	......	"	"	"	7′ 2″	10	"	50	5000
Double decked, open body.	24′ 9″	.....	... ..	15′ 3″	......	.....	6′ 10″	7	"	below 35 top 24	4400
Double decked, closed body.	35′	25′ 6″	4′ 9″	15′	......	......	7′ 6″	...	.. ....	below 36 top 36	7500
Funeral-car, motor or trail.	20′	13′10″	3′ 1″	......	......	8′ 2″	7′	....	....	... .	3900

APPROXIMATE DIMENSIONS VARIOUS STYLES OF ELECTRIC CARS.

TRAIL CARS.

Kind. (Closed—See MOTOR CARS.)	Length over Platforms.	Length over Posts.	Length of Platforms.	Height over All.	Size of Wheels.	Height Inside.	Width.	Number of Seats.	Kind of Seats.	Seating Capacity.	Weight of Body. lbs.
Open	24′	19′	2′6″	10′ 6″ to 11′ 6″	33″	7′8″ to 8′6″	7′	18	10 reversible ½ seats, 8 station'y ½ seats, c'tre aisle	36	3800
"	25′	.....	......	"	33″	"	7′ 6″	10	vis-à-vis stationary back	50	4000
"	29′ 6″	25′	2′ 3″	"	33″	"	......	10	8 reversible, 2 stationary	50	4400
"	44′	37′ 6″	3′ 3″	"	33″	"	8′	15	13 reversible, 2 stationary	90	9000
Convertible summer and winter.	23′	16′ 7″	3′ 3½″	"	33″	"	7′ 8″	12	6½ seats each side of aisle	24	4600
Double decked, open body.	24′ 9″	......	......	15′ 3″	33″	....	6′ 10″	7	reversible	below 35 top 24	4400
Double decked, closed body.	26′	15′10″	5′ 5″	......	....	...	7′ 6″	...	....	below 22 top 22	4000
Double decked, closed body.	34′	28′	3′	16′	33″	8′6″	8′	....	....	below 48 top 40	12000
4-wheel gondola.....	13′10″	......	......	......	....	...	7′ 10″	....	....	10,000 lbs.	3250
4-wheel box-car......	15′ 3″	12′ 3″	1′ 6″	......	....	6′3″	6′ 6″	....	....	11,000 "	3800
Express and baggage	21′	...	......	......	....	...	7′ 3″	....	....	....	5000

APPROXIMATE WEIGHTS OF TRUCKS.

Kind.	Weight.
Single truck for motor car........	3500 lbs.
Maximum traction........................	2600 "
Pivotal, motor car..	3000 "
" trail car....,....................	1500 "
Radial..................................	3700 "
Running gear............................	1500 "

TORQUE AND HORSE-POWER.

H.P. per Lb. Applied at Periph. at 100 Rev. per Min.

Diameter Wheel.	26″	28″	30″	33″	36″
H.P.	.02062	.02221	.0238	.02618	.02856

Pounds at Periphery per H.P. at 100 Rev. per Min.

Diameter Wheel.	26″	28″	30″	33″	36″
Lbs.	48.481	45.018	42.017	38.197	35.014

$$\text{Lbs.} = \frac{126050.9 \times \text{H.P.}}{\text{Diam.} \times \text{rev.}}.$$

H.P. = .00000793 × diam. wheel × rev. × lbs. at periph.
H.P. per lb. at periph. at one mile per hour = .002867.
Lbs. at periph. per H.P. at one mile per hour = 374.9.

REVOLUTIONS PER MINUTE AT ONE MILE PER HOUR.

Diameter Wheel.	26″	28″	30″	33″	36″
Rev.	12.93	12	11.2	10.18	9.336

$$\text{Rev.} = \frac{336.12}{\text{diam.}}.$$

MILES PER HOUR IN FEET PER MINUTE AND PER SECOND.

Miles per Hour.	Feet per Minute.	Feet per Second.	Miles per Hour.	Feet per Minute.	Feet per Second.
1	88	1.46	16	1,408	23.47
2	176	2.94	17	1,496	24.93
3	264	4.4	18	1,584	26.4
4	352	5.87	19	1,672	27.86
5	440	7.33	20	1,760	29.33
6	548	8.8	21	1,848	30.8
7	616	10.26	22	1,936	32.26
8	704	11.73	23	2,024	33.72
9	792	13.2	24	2,112	35.2
10	880	14.67	25	2,200	36.67
11	968	16.13	26	2,288	38.14
12	1,056	17.6	27	2,376	39.6
13	1,144	19.07	28	2,464	41.04
14	1,232	20.52	29	2,552	42.50
15	1,320	22	30	2,640	44

HEADWAY, SPEED, AND TOTAL NUMBER OF CARS.

Total number of cars on a given length of street on which cars are running both ways = (length of street × 120) ÷ (headway in minutes × speed in miles per hour).

TRACTION.

THEORETICAL H.P. PER TON OF 2000 LBS. AND PER MILE PER HOUR WITH VARIOUS GRADES AND COEFFICIENTS.

% Grade.	Coefficient.										
	12	13.5	15	18	20	25	30	35	40	50	60
0	.032	.036	.04	.048	.05⅓	.06⅔	.08	.09⅓	.10⅔	.13⅓	.16
1	.085⅓	.089⅓	.09⅓	.101⅓	.10⅔	.12	.13⅓	.14⅔	.16	.18⅔	.21⅓
2	.138⅔	.142⅔	.14⅔	.154⅔	.16	.17⅓	.18⅔	.20	.21⅓	.24	.26⅔
3	.192	.196	.20	.208	.21⅓	.22⅔	.24	.25⅓	.26⅔	.29⅓	.32
4	.245⅓	.249⅓	.25⅓	.261⅓	.26⅔	.28	.29⅓	.30⅔	.32	.34⅔	.37⅓
5	.298⅔	.302⅔	.30⅔	.314⅔	.32	.33⅓	.34⅔	.36	.37⅓	.40	.42⅔
6	.352	.356	.36	.368	.37⅓	.38⅔	.40	.41⅓	.42⅔	.45⅓	.48
7	.405⅓	.409⅓	.41⅓	.421⅓	.42⅔	.44	.45⅓	.46⅔	.48	.50⅔	.53⅓
8	.458⅔	.462⅔	.46⅔	.474⅔	.48	.49⅓	.50⅔	.52	.53⅓	.56	.58⅔
9	.512	.516	.52	.528	.53⅓	.54⅔	.56	.57⅓	.58⅔	.61⅓	.64
10	.565⅓	.569⅓	.57⅓	.581⅓	.58⅔	.60	.61⅓	.62⅔	.64	.66⅔	.69⅓
11	.618⅔	.622⅔	.62⅔	.634⅔	.64	.65⅓	.66⅔	.68	.69⅓	.72	.74⅔
12	.672	.676	.68	.688	.69⅓	.70⅔	.72	.73⅓	.74⅔	.77⅓	.80
13	.725⅓	.729⅓	.73⅓	.741⅓	.74⅔	.76	.77⅓	.78⅔	.80	.82⅔	.85⅓
14	.778⅔	.782⅔	.78⅔	.794⅔	.80	.81⅓	.82⅔	.84	.85⅓	.88	.90⅔
15	.832	.836	.84	.848	.85⅓	.86⅔	.88	.89⅓	.90⅔	.93⅓	.96

$\text{H.P.} = .002\tfrac{2}{3}[K + (20 \times \%\ \text{grade})].$

POLES.

DIMENSIONS AND WEIGHTS WROUGHT-IRON AND STEEL POLES.

Length.	Diameter.	Weights.
27′	5″, 4″, 3″	350 lbs. to 515 lbs.
28′	6″, 5″, 4″	475 " to 725 "
30′	6″, 5″, 4″	510 " to 775 "
30′	7″, 6″, 5″	600 " to 1000 "
28′	8″, 7″, 6″	775 " to 1260 "
30′	8″, 7″, 6″	825 " to 1350 "

CUBIC CONTENTS OF WOODEN POLES, IN FEET.

Length.	Diameter.	Section.	Cubic Feet.
27′	6″ × 8″	Circular	7.36
27′	7″ × 9″	"	9.56
27′	7″ × 9″	Octagonal	10.1
28′	7″ × 9″	Circular	9.92
28′	7″ × 9″	Octagonal	10.46
28′	8″ × 10″	Circular	12.52
28′	8″ × 10″	Octagonal	13.2
30′	7″ × 9″	Circular	10.63
30′	7″ × 9″	Octagonal	11.21
30′	8″ × 10″	Circular	13.41
30′	8″ × 10″	Octagonal	14.15
30′	9″ × 12″	"	19.06

AVERAGE WEIGHTS OF VARIOUS WOODS, IN POUNDS.

Kind.	Condition.	Weight per Cubic Foot.
Live oak...................	Perfectly dry	59
White oak................	" "	48
Red "	" "	85
Chestnut............	" "	41
Southern yellow pine.. .	" "	45
Northern " "	" "	34
Long-leaf " "	Unseasoned	65
Norway pine...	Perfectly dry	46
Spruce...................	" "	25
Hemlock.	" "	25

The weight of green woods may be from one-fifth to half greater than the weight when perfectly dry.

DIP IN SPAN WIRE.

The following tables give the dip of the span wire in inches under the combined weight of span wire and trolley wire for various spans and strains. Length of trolley wire between supports, 125′. Weight of trolley wire, 319 lbs. per 1000′. Weight of span wire, 210 lbs. per 1000′.

SINGLE TROLLEY WIRE.

Span in Feet.	Strain on Poles, in Pounds.						
	500	800	1000	1500	2000	2500	3000
30	7.8	4.9	3.9	2.6	1.9		
40	10.6	6.5	5.3	3.5	2.7		
50	13.6	8.5	6.8	4.5	3.4	2.7	
60	16.7	10.4	8.3	5.6	4.2	3.3	2.8
70	19.9	12.4	9.9	6.6	4.9	4	3.3
80	23.2	14.5	11.6	7.7	5.6	4.6	3.9
90	26.7	16.7	13.4	8.9	6.6	5.3	4.5
100	30.3	18.9	15.2	10.1	7.6	6.1	5.1
110	34	21.3	17	11.3	8.5	6.8	5.7
120	37.9	23.7	18.9	12.6	9.5	7.6	6.3

TWO TROLLEY WIRES, 10′ APART.

Span in Feet.	Strain on Poles, in Pounds.							
	500	800	1000	1500	2000	2500	3000	3500
40	15.4	9.6	7.7	5.1	3.9	3.1		
50	20.8	13	10.4	6.9	5.2	4.2		
60	26.3	16.4	13.1	8.8	6.6	5.3	4.4	
70	31.9	19.9	15.9	10.6	8	6.4	5.3	
80	37.6	23.5	18.8	12.5	9.4	7.5	6.3	5.4
90	43.5	27.2	21.8	14.5	10.9	8.7	7.3	6.2
100	49.5	30.9	24.8	16.5	12.4	9.9	8.3	7.1
110	55.6	34.7	27.8	18.5	13.9	11.1	9.3	7.9
120	61.9	38.7	30.9	20.6	15.5	12.4	10.3	8.7

The following tables give the dip in feet and inches of No. 0 B. & S. copper trolley wire between spans 125′ apart, and the strain in pounds, for various temperatures:

INITIAL MAXIMUM STRAIN 2000 LBS.

Temperature F.	Dip.	Strain.
– 10°	3.7″	2000 lbs.
0°	9.7″	774 "
32°	1′ 6″	415 "
50°	1′ 10″	340 "
70°	2′ 1″	300 "
90°	2′ 4″	267 "
10°	3.7″	2000 "
32°	1′ 2″	534 "
50°	1′ 6″	415 "
70°	1′ 10″	340 "
90°	2′ 1″	300 "
32°	3.7″	2000 "
50°	1′	623 "
70°	1′ 5″	440 "
90°	1′ 10″	340 "

From the preceding tables the proper height of eye-bolts can be determined for various spans and temperatures with a given minimum height of trolley wire above the track.

TABLES OF COPPER WIRE.

No. B. & S. Gauge.	Diameter Mils.	Area.		Weight and Length. Sp. gr. 8.9.			Legal Ohms per 1000′ at 70° F.			
		Circular Mils (d^2). 1 mil = .001 in.	Square Inches ($d^2 \times .7854$).	Lbs. per 1000 Ft.	Lbs. per Mile.	Feet per Pound.	Conductivity in %.			
							100	99	98	97
0000	460.000	211600.00	.166190	639.33	3375.7	1.56	.04925	.04975	.05026	.05077
000	409.640	167805.00	.131790	507.01	2677.0	1.97	.06211	.06274	.06337	.06403
00	364.800	133079.04	.104520	402.09	2123.0	2.49	.07832	.07911	.07991	.08170
0	324.860	105534.03	.082932	319.04	1684.5	3.13	.09876	.09976	.10077	.10177
1	289.300	83694.20	.065733	252.88	1335.2	3.95	.12453	.12578	.12707	.12838
2	257.630	66373.00	.052130	200.54	1058.8	4.99	.15703	.15862	.16024	.16188
3	229.420	52633.40	.041339	159.03	839.68	6.29	.19803	.20002	.20206	.20415
4	204.310	41742.57	.032784	126.12	665.91	7.93	.24970	.25222	.25479	.25742
5	181.940	33102.00	.025998	100.01	528.05	10.00	.31487	.31805	.32129	.32461
6	162.020	26250.50	.020617	79.32	418.81	12.61	.39706	.40107	.40516	.40934
7	144.280	20816.70	.016349	62.90	332.11	15.90	.50069	.50575	.51091	.51618
8	128.490	16509.00	.012966	49.88	263.37	20.05	.63134	.63775	.64422	.65086
9	114.430	13094.00	.010284	39.56	208.88	25.28	.79600	.80404	.81224	.82061
10	101.890	10381.00	.0081532	31.37	165.63	31.38	1.00403	1.01417	1.02462	1.03508
11	90.742	8234.10	.0064670	24.88	137.37	40.20	1.26581	1.27860	1.29169	1.30496
12	80.808	6529.90	.0051286	19.73	104.18	50.69	1.59617	1.61229	1.62874	1.64554
13	71.961	5178.40	.0040671	15.65	82.632	63.91	2.01275	2.03308	2.05383	2.07500
14	64.084	4106.80	.0031469	12.41	65.525	80.59	2.53795	2.56358	2.58974	2.61644

TABLES OF COPPER WIRE—*Continued.*

No. B. W. G. Gauge.	Diameter Mils.	Area.		Weight and Length. Sp. gr. 8.9.			Legal Ohms per 1000′ at 70° F.			
		Circular Mils (d^2). 1 mil = .001 in.	Square Inches ($d^2 \times .7854$).	Lbs. per 1000 Ft.	Lbs. per Mile.	Feet per Pound.	Conductivity in %. 100	99	98	97
0000	454	206116	.16188351	623.925	3294.32	1.6027	.05057	.05108	.05159	.05213
000	425	180625	.14186288	546.760	2886.88	1.8285	.05770	.05829	.05888	.05949
00	380	144400	.11341176	437.107	2308.02	2.2878	.07218	.07291	.07365	.07441
0	340	115600	.09079224	349.928	1847.62	2.8577	.09016	.09107	.09200	.09295
1	300	90000	.07068600	272.435	1438.46	3.6706	.11581	.11698	.11817	.11939
2	284	80656	.06334722	244.150	1289.11	4.0958	.12928	.13058	.13786	.13322
3	259	67081	.05268594	202.964	1071.65	4.927	.15545	.15702	.15862	.16025
4	238	56644	.04448820	171.465	905.34	5.832	.18443	.18629	.18819	.19018
5	220	48400	.03801330	146.510	773.57	6.8255	.21485	.21702	.21923	.22149
6	203	41209	.03236555	124.742	658.64	8.0165	.25309	.25565	.25826	.26092
7	180	32400	.02544696	98.076	517.84	10.1962	.32169	.32494	.32826	.33164
8	165	27225	.02138456	82.41	435.12	12.1345	.38284	.38671	.39065	.39468
9	148	21904	.01720340	66.305	350.09	15.0818	.47562	.48043	.48533	.49033
10	134	17956	.01410264	54.354	286.99	18.3979	.58046	.58632	.59231	.59841
11	120	14400	.01130976	43.59	230.16	22.941	.72381	.73112	.73858	.74619
12	109	11881	.00933154	35.964	189.89	27.856	.87726	.88613	.89517	.90439
13	95	9025	.00708824	27.319	144.24	36.6046	1.15488	1.16655	1.17845	1.19060
14	83	6889	.00541062	20.853	110.10	47.9547	1.59880	1.61293	1.62939	1.64619

RESISTANCES BASED ON STANDARD ADOPTED BY A. I. E. E.

Viz.: Resistance one mil-foot soft copper wire at 0° C. = 9.612 legal ohms.

$$C_t = C_0(1 - .00387t + .000009009t^2).$$
$$R_t = R_0(1 + .00387t + .00000597t^2).$$
t in degrees centigrade.

Resistance one mil-foot 70° F. = 10.4228. Assuming conductivity at this resistance = 100, with

$C = 99$, $R = 10.5281$ legal ohms.
$C = 98$, $R = 10.6355$ " "
$C = 97$, $R = 10.7452$ " "

Resistance in legal ohms × 1.0112 = resistance in B. A. ohms.

By Matthiessen's Standard.

Resistance hard-drawn copper wire = resistance soft-drawn copper wire × 1.0226.

Expansion of copper per degree F. = .000009545.
" " " " C. = .000017182.

BREAKING WEIGHTS COPPER AND SILICON BRONZE WIRES.

Breaking weight hard-drawn copper wire per 1000 C. M. = 47.12 lbs.

Breaking weight soft-drawn or annealed copper wire per 1000 C. M. = 26.69 lbs.

Breaking weight No. 0 B. & S. hard-drawn copper wire = 4973 lbs.

Breaking weight No. 0 B. & S. soft-drawn or annealed copper wire = 2817 lbs.

Breaking weight silicon bronze wire per square inch, 80920 lbs.

Breaking weight No. 4 B. W. G. silicon bronze wire, 3600 lbs.

WEIGHTS OF COPPER AND SILICON BRONZE WIRES.

Weight copper wire per mile $= \frac{\text{C.M.}}{62.567}$.

" " " " 1000 ft. $= \frac{\text{C.M.}}{330.353}$.

Weight of silicon bronze wire approximately the same as corresponding size in copper.

WEIGHTS OF IRON AND STEEL WIRE.

No. B. & S.	Diameter in Mils.	Weight per 1000′.	
		Wrought Iron.	Steel.
0000	460	561	566
000	409.64	445	449
00	364.8	353	356
0	324.86	280	282
1	289.3	222	224
2	257.63	176	178
3	229.42	139	141
4	204.31	111	112
5	181.94	87.7	88.5
6	162.02	69.6	70.2
7	144.28	55.2	55.7
8	128.49	43.8	44.1
9	114.43	34.7	35
10	101.89	27.5	27.8
11	90.74	21.8	22
12	80.81	17.3	17.5

WEIGHTS AND TENSILE STRENGTH E. B. B. GALVANIZED TELEGRAPH WIRE.

No. B. W. G.	Weight per Mile.	Breaking Weight.
4	730	1898
6	540	1404
8	380	988
9	330	858
10	260	676
11	214	556
12	165	429
14	96	250

GALVANIZED SIGNAL STRAND. SEVEN WIRES.

Diameter. Inches.	Weight per 1000′.			Estimated Breaking Weight.
	Bare Strand.	Double Braid W. P.	Triple Braid W. P.	
1-2	520	616	677	8320
15-32	420	510	561	6720
7-16	360	444	488	5720
3-8	290	362	398	4640
5-16	210	270	297	3360
9-32	160	214	235	2560
17-64	120	171	188	1920
1-4	100	148	163	1600
7-32	80	122	134	1280
3-16	60	96	105	960
11-64	43	76	84	688
9-64	33	60	66	528
1-8	24	48	53	384
3-32	20	38	42	320

SPIKES.

Size.	No. per Keg of 200 Lbs.	Lbs. per Spike.	Spikes per L
4½ × ½	533	.3752	2.66
5 × 7/16	650	.3077	3.25
5 × ½	520	.3846	2.6
5 × 9/16	393	.5089	1.96
5½ × ½	466	.4292	2.33
5½ × 9/16	384	.5208	1.92
6 × 9/16	350	.5714	1.75
6 × ⅝	260	.7692	1.3

SPIKES PER 1000′ AND PER MILE SINGL TRACK, WITH FOUR SPIKES PER TIE.

Spacing of Ties.	Per 1000′.	Per Mile.
10 ties to 30′ rail................	1333⅓	7040
11 " " " "	1466⅔	7744
12 " " " "	1600	8448
13 " " " "	1733⅓	9152
14 " " " "	1866⅔	9856
15 " " " "	2000	10560
16 " " " "	2133⅓	11264

JOINTS.

	Per 1000′.	Per Mile.
Joints—30′ rails..................	66⅔	352
Angle bars......................	133⅓	704
Bolts—4 hole bars................	266⅔	1408
" 6 " "	400	2112

WEIGHTS OF RAILS.

Pounds per Yard.	Weight per Mile. Long Tons.		Weight per 1000′. Long Tons.	
25	$39\frac{640}{2240}$	39.286	$7\frac{986.7}{2240}$	7.441
30	$47\frac{320}{2240}$	47.143	$8\frac{2080}{2240}$	8.929
35	55	55	$10\frac{933.3}{2240}$	10.417
40	$62\frac{1920}{2240}$	62.857	$11\frac{2026.6}{2240}$	11.905
45	$70\frac{1600}{2240}$	70.714	$13\frac{880}{2240}$	13.393
48	$74\frac{960}{2240}$	74.428	$14\frac{635.5}{2240}$	14.284
50	$78\frac{1280}{2240}$	78.571	$14\frac{1973.3}{2240}$	14.881
52	$81\frac{1600}{2240}$	81.714	$15\frac{1066.7}{2240}$	15.477
55	$86\frac{960}{2240}$	86.428	$16\frac{826.6}{2240}$	16.369
56	88	88	$16\frac{1604.4}{2240}$	16.667
58	$91\frac{320}{2240}$	91.143	$17\frac{586.7}{2240}$	17.262
58½	$91\frac{2080}{2240}$	91.928	$17\frac{1920}{2240}$	17.411
60	$94\frac{640}{2240}$	94.286	$17\frac{920}{2240}$	17.857
62	$97\frac{960}{2240}$	97.428	$18\frac{1013.3}{2240}$	18.452
63	99	99	$18\frac{1680}{2240}$	18.75
63½	$99\frac{1760}{2240}$	99.785	$18\frac{2013.3}{2240}$	18.899
65	$102\frac{320}{2240}$	102.143	$19\frac{773.3}{2240}$	19.345
66	$103\frac{1600}{2240}$	103.714	$19\frac{1440}{2240}$	19.643
66½	$104\frac{1120}{2240}$	104.5	$19\frac{1773.3}{2240}$	19.792
67	$105\frac{640}{2240}$	105.286	$19\frac{2106.}{2240}$	19.940

WEIGHTS OF RAILS—*Continued.*

Pounds per Yard.	Weight per Mile. Long Tons.		Weight per 1000′. Long Tons.	
68	$106\frac{1920}{2240}$	106.857	$20\frac{533.3}{2240}$	20.238
70	110	110	$20\frac{2000}{2240}$	20.833
71	$111\frac{280}{2240}$	111.125	$21\frac{293.3}{2240}$	21.131
72	$113\frac{320}{2240}$	113.143	$21\frac{960}{2240}$	21.429
75	$117\frac{1920}{2240}$	117.857	$22\frac{720.2}{2240}$	22.322
77	121	121	$22\frac{2053.3}{2240}$	22.917
78	$122\frac{320}{2240}$	122.143	$23\frac{480}{2240}$	23.214
80	$125\frac{1600}{2240}$	125.714	$23\frac{1813.3}{2240}$	23.810
82	$129\frac{1920}{2240}$	129.857	$24\frac{906.6}{2240}$	24.405
85	$133\frac{1280}{2240}$	183.571	$25\frac{666.6}{2240}$	25.298
90	$141\frac{960}{2240}$	141.428	$26\frac{1760}{2240}$	26.786
91	143	143	$27\frac{186.6}{2240}$	27.083
98	154	154	$29\frac{373.3}{2240}$	29.167
100	$157\frac{320}{2240}$	157.143	$29\frac{1706.7}{2240}$	29.762

For iron or steel weighing 480 lbs. per cubic foot: Cross-section in square inches = weight in lbs. per yard ÷ 10.

For iron or steel having $\frac{1}{7}$ conductivity of copper: Weight in lbs. per yard ÷ 11.6333 = number of 4-0 B. & S. copper wires with combined equivalent carrying-capacity. Also, weight in lbs. per yard × 18189.1 = C. M. of equivalent copper wire.

TIES PER 1000' AND PER MILE.

Spacing.	Per 1000'.	Per Mile.
10 ties to 30' rail..................	333⅓	1760
11 " " " "	366⅔	1936
12 " " " "	400	2112
13 " " " "	433⅓	2288
14 " " " "	466⅔	2464
15 " " " "	500	2640
16 " " " "	533⅓	2816

BOARD FEET, CUBIC FEET, AND SQUARE FEET OF BEARING SURFACE PER TIE.

Size.	Board Feet.	Cubic Feet.	Bearing Surface.
5"× 5"×7'	14.56	1.213	2.91
5"× 6"×7'	17.5	1.458	3.5
5"× 7"×7'	20.41	1.7	4.08
5"× 8"×7'	23.33	1.944	4.66
6"× 6"×7'	21	1.75	3.5
6"× 7"×7'	24.5	2.041	4.08
6"× 8"×7'	28	2.333	4.66
6"× 9"×7'	31.5	2.625	5.25
6"×10"×7'	35	2.916	5.83
6"× 8"×8'	32	2.666	5.33
6"× 9"×8'	36	3	6
6"×10"×8'	40	3.333	6.66

MIDDLE ORDINATES FOR CHORDS OF 100′.

Radius.	Middle Ordinate.	Radius.	Middle Ordinate.
100′	13′ 4.8″	300′	4′ 2.4″
125′	10′ 6″	350′	3′ 7.2″
150′	8′ 7.2″	400′	3′ 1.2″
175′	7′ 3.6″	450′	2′ 9.6″
200′	6′ 4.2″	500′	2′ 6″
225′	5′ 7.5″	550′	2′ 3.3″
250′	5′ 1.2″	600′	2′ 1.2″
275′	4′ 7.2″		

MIDDLE ORDINATES FOR CHORDS OF 10′.

Radius.	Middle Ordinate.	Radius.	Middle Ordinate.
25′	6.06″	62½′	2.39″
27½′	5.5″	65′	2.3″
30′	5.04″	67½′	2.22″
32½′	4.66″	70′	2.14″
35′	4.32″	75′	1.99″
37½′	4.02″	80′	1.87″
40′	3.76″	85′	1.76″
42½′	3.54″	90′	1.67″
45′	3.34″	95′	1.58″
47½′	3.16″	100′	1.5″
50′	3″	120′	1.25″
52½′	2.86″	150′	1″
55′	2.74″	200′	.75″
57½′	2.62″	250′	.6″
60′	2.5″	300′	.5″

MIDDLE ORDINATES AND CHORDS FOR ARC OF 30'.

Radius.	Chord.	Middle Ordinate.	Radius.	Middle Ordinate.
35'	29' 1"	3' 2"	72½'	1' 6.5"
37½'	29' 2.4"	2' 11.5"	75'	1' 5.9"
40'	29' 3.6"	2' 9.35"	77½'	1' 5.3"
42½'	29' 4.6"	2' 7.4"	80'	1' 4.8"
45'	29' 5.4"	2' 5.7"	85'	1' 3.8"
47½'	29' 6"	2' 4.2"	90'	1' 3"
50'	29' 6.6"	2' 2.8"	95'	1' 2.2"
52½'	29' 7.1"	2' 1.5"	100'	1' 1.5"
55'	29' 7.5"	2' .4"	110'	1' .25"
57½'	29' 7.9"	1' 11.3"	120'	11.25"
60'	29' 8.3"	1' 10.4"	130'	10.37"
62½'	29' 8.6"	1' 9.5"	150'	9"
65'	29' 8.8"	1' 8.7"	175'	7.75"
67½'	29' 9"	1' 7.9"	200'	6.75"
70'	29' 9.2"	1' 7.2"	250'	5.4"
			300'	4.5"

LENGTH OF CIRCULAR ARCS WHOSE RADIUS IS 1.

For each degree,	.0174533
" " minute,	.0002909
" " second,	.0000048

ELEVATION OF OUTSIDE RAIL.

	Speed in Miles per Hour.							
	3	4	5	6	7	8	9	10
Constant.	33.969	60.389	94.353	135.876	184.917	241.557	305.721	377.412

	Speed in Miles per Hour.							
	12	15	18	20	25	30	35	40
Constant.	543.505	849.18	1222.88	1409.65	2358.82	3396.90	4622.92	6039.25

Elevation in inches = constant ÷ radius of curve in feet.

PAVING.

Square yards of paving between rails, 4′ 8½″ gauge, less 4″ for width of carriage tread:

Per 1000′ run = 485.89
Per mile run = 2565.5

Square yards paving for 18″ outside both rails:

Per 1000′ run = 333⅓
Per mile run = 1760

EXCAVATION.

Cubic yards excavation for each foot in width and inch in depth, straight sides:

Per 1000′ run = 3.08
Per mile run = 16.29

NATURAL SLOPES OF EARTH.

Material.	Slope.	
	Angle.	Ratio.
Compact earth	50°	.84 to 1
Rubble	45°	1 to 1
Clay (drained)	45°	1 to 1
Gravel	40°	1.2 to 1
Shingle	39°	1.23 to 1
Dry sand	38°	1.28 to 1
Vegetable earth	28°	1.88 to 1
Sand	22°	2.47 to 1
Clay (wet)	16°	3.5 to 1

CUTS AND FILLS.

To estimate cubic contents, assuming parallel end faces, parallel top and bottom surfaces, and uniform section.

l = **length.**

dp = **perpendicular height or depth.**

wd = **width at bottom of cut or top of fill.**

Dimensions in lineal feet, results in cubic yards.

Slope 1 to 1:

$$\text{Cu. yds.} = .03704l \,.\, dp(wd + dp).$$

Slope 1½ to 1:

$$\text{Cu. yds.} = .03704l \,.\, dp(wd + 1\tfrac{1}{2}dp).$$

Slope 2 to 1:

$$\text{Cu. yds.} = .03704l \,.\, dp(wd + 2dp).$$

Slope 2½ to 1:

$$\text{Cu. yds.} = .03704l \,.\, dp(wd + 2\tfrac{1}{2}dp).$$

To estimate cubic contents of wedge-shaped end of cut, assuming *horizontal base* and uniform decrease in depth from maximum to zero.

Slope 1 to 1:

$$\text{Cu. yds.} = .006172l \,.\, dp(3wd + 2dp).$$

Slope 1½ to 1:

$$\text{Cu. yds.} = .006172l \,.\, dp(3wd + 3dp)$$
$$= .018516l \,.\, dp(wd + dp).$$

Slope 2 to 1:

$$\text{Cu. yds.} = .006172l \,.\, dp(3wd + 4dp).$$

Slope 2½ to 1:

$$\text{Cu. yds.} = .006172l \,.\, dp(3wd + 5dp).$$

The above formulæ are true for fill having *horizontal top surface*, and uniform decrease in depth from maximum to zero.

To estimate cubic contents of wedge-shaped end of fill, assuming *horizontal base* and uniform decrease in depth from maximum to zero.

Slope 1 to 1:

$$\text{Cu. yds.} = .006172l \,.\, dp(3wd + 4dp).$$

Slope 1½ to 1:

$$\text{Cu. yds.} = .006172l \,.\, dp(3wd + 6dp)$$
$$= .018516l \,.\, dp(wd + 2dp).$$

Slope 2 to 1:

$$\text{Cu. yds.} = .006172l \,.\, dp(3wd + 8dp).$$

Slope 2½ to 1:

$$\text{Cu. yds.} = .006172l \,.\, dp(3wd + 10dp).$$

TH IN EMBANKMENT.

CUBIC YARDS IN FILL FOR 100
ND PERCENTAGE OF LOSS.

	Cubic Yards in Fill per 100 in Cut.	Per Cent Loss.
. .	92	8
. .	90	10
. .	88	12
oil	85	15
. .	75	25

NE IN EMBANKMENT.

CUBIC YARDS OF BROKEN STONE
YARDS OF SOLID ROCK IN CUT,
NCREASE.

Cu. Yds. in Fill per 100 Cu. Yds. in Cut.	Per Cent Increase.	Per Cent.	
		Solid.	Voids
190	90	52.6	47.4
175	75	57	43
160	60	63	37
150	50	67	33
125	25	80	20

T COMPACT EARTHS,
S. PER CUBIC YARD.

.	Material.	Weight.
	Chalk..	4030
	Clay........ ...	3470
	Sand........ ..	3360
	Gravel	3360
	Marl.....	2900
	Mud...	2800

TABLE OF SQUARES, CUBES, SQUARE ROOTS, CUBE ROOTS, AND RECIPROCALS OF NUMBERS FROM 1 TO 1000.

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
1	1	1	1.0000	1.0000	1.000000000
2	4	8	1.4142	1.2599	.500000000
3	9	27	1.7321	1.4422	.333333333
4	16	64	2.0000	1.5874	.250000000
5	25	125	2.2361	1.7100	.200000000
6	36	216	2.4495	1.8171	.166666667
7	49	343	2.6458	1.9129	.142857143
8	64	512	2.8284	2.0000	.125000000
9	81	729	3.0000	2.0801	.111111111
10	100	1000	3.1623	2.1544	.100000000
11	121	1331	3.3166	2.2240	.090909091
12	144	1728	3.4641	2.2894	.083333333
13	169	2197	3.6056	2.3513	.076923077
14	196	2744	3.7417	2.4101	.071428571
15	225	3375	3.8730	2.4662	.066666667
16	256	4096	4.0000	2.5198	.062500000
17	289	4913	4.1231	2.5713	.058823529
18	324	5832	4.2426	2.6207	.055555556
19	361	6859	4.3589	2.6684	.052631579
20	400	8000	4.4721	2.7144	.050000000
21	441	9261	4.5826	2.7589	.047619048
22	484	10648	4.6904	2.8020	.045454545
23	529	12167	4.7958	2.8439	.043478260
24	576	13824	4.8990	2.8845	.041666667
25	625	15625	5.0000	2.9240	.040000000
26	676	17576	5.0990	2.9625	.038461538
27	729	19683	5.1962	3.0000	.037037037
28	784	21952	5.2915	3.0366	.035714286
29	841	24389	5.3852	3.0723	.034482759
30	900	27000	5.4772	3.1072	.033333333
31	961	29791	5.5678	3.1414	.032258065
32	1024	32768	5.6569	3.1748	.031250000
33	1089	35937	5.7446	3.2075	.030303030
34	1156	39304	5.8310	3.2396	.029411765
35	1225	42875	5.9161	3.2711	.028571429

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
36	1296	46656	6.0000	3.3019	.027777778
37	1369	50653	6.0828	3.3322	.027027027
38	1444	54872	6.1644	3.3620	.026315789
39	1521	59319	6.2450	3.3912	.025641026
40	1600	64000	6.3246	3.4200	.025000000
41	1681	68921	6.4031	3.4482	.024390244
42	1764	74088	6.4807	3.4760	.023809524
43	1849	79507	6.5574	3.5034	.023255814
44	1936	85184	6.6332	3.5303	.022727273
45	2025	91125	6.7082	3.5569	.022222222
46	2116	97336	6.7823	3.5830	.021739130
47	2209	103823	6.8557	3.6088	.021276600
48	2304	110592	6.9282	3.6342	.020833333
49	2401	117649	7.0000	3.6593	.020408163
50	2500	125000	7.0711	3.6840	.020000000
51	2601	132651	7.1414	3.7084	.019607843
52	2704	140608	7.2111	3.7325	.019230769
53	2809	148877	7.2801	3.7563	.018867925
54	2916	157464	7.3485	3.7798	.018518519
55	3025	166375	7.4162	3.8030	.018181818
56	3136	175616	7.4833	3.8259	.017857143
57	3249	185193	7.5498	3.8485	.017543860
58	3364	195112	7.6158	3.8709	.017241379
59	3481	205379	7.6811	3.8930	.016949153
60	3600	216000	7.7460	3.9149	.016666667
61	3721	226981	7.8102	3.9365	.016393443
62	3844	238328	7.8740	3.9579	.016129032
63	3969	250047	7.9373	3.9791	.015873016
64	4096	262144	8.0000	4	.015625000
65	4225	274625	8.0623	4.0207	.015384615
66	4356	287496	8.1240	4.0412	.015151515
67	4489	300763	8.1854	4.0615	.014925373
68	4624	314432	8.2462	4.0817	.014705882
69	4761	328509	8.3066	4.1016	.014492754
70	4900	343000	8.3666	4.1213	.014285714
71	5041	357911	8.4261	4.1408	.014084507
72	5184	373248	8.4853	4.1602	.013888889
73	5329	389017	8.5440	4.1793	.013698630
74	5476	405224	8.6023	4.1983	.013513514
75	5625	421875	8.6603	4.2172	.013333333

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
76	5776	438976	8.7178	4.2358	.013157895
77	5929	456533	8.7750	4.2543	.012987013
78	6084	474552	8.8318	4.2727	.012820513
79	6241	493039	8.8882	4.2908	.012658228
80	6400	512000	8 9443	4.3089	.012500000
81	6561	531441	9	4.3267	.012345679
82	6724	551368	9.0554	4.3445	.012195122
83	6889	571787	9.1104	4.3621	.012048193
84	7056	592704	9.1652	4.3795	.011904762
85	7225	614125	9.2195	4.3968	.011764706
86	7396	636056	9.2736	4.4140	.011627907
87	7569	658503	9.3274	4.4310	.011494253
88	7744	681472	9.3808	4.4480	.011363636
89	7921	704969	9.4340	4.4647	.011235955
90	8100	729000	9.4868	4.4814	.011111111
91	8281	753571	9.5394	4.4979	.010989011
92	8464	778688	9.5917	4.5144	.010869565
93	8649	804357	9.6437	4.5307	.010752688
94	8836	830584	9 6954	4.5468	.010638298
95	9025	857375	9.7468	4.5629	.010526316
96	9216	884736	9.7980	4.5789	.010416667
97	9409	912673	9.8489	4.5947	.010309278
98	9604	941192	9.8995	4.6104	.010204082
99	9801	970299	9.9499	4.6261	.010101010
100	10000	1000000	10	4.6416	.010000000
101	10201	1030301	10.0499	4.6570	.009900990
102	10404	1061208	10.0995	4.6723	.009803922
103	10609	1092727	10.1489	4.6875	.009708738
104	10816	1124864	10.1980	4.7027	.009615385
105	11025	1157625	10.2470	4.7177	.009523810
106	11236	1191016	10.2956	4.7326	.009433962
107	11449	1225043	10.3441	4.7475	.009345794
108	11664	1259712	10.3923	4.7622	.009259259
109	11881	1295029	10.4403	4.7769	.009174312
110	12100	1331000	10.4881	4.7914	009090909
111	12321	1367631	10.5357	4.8059	.009009009
112	12544	1404928	10.5830	4.8203	.008928571
113	12769	1442897	10.6301	4.8346	.008849558
114	12996	1481544	10.6771	4.8488	.008771930
115	13225	1520875	10.7238	4.8629	.008695652

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
116	13456	1560896	10.7703	4.8770	.008620690
117	13689	1601613	10.8167	4.8910	.008547009
118	13924	1643032	10.8628	4.9049	.008474576
119	14161	1685159	10.9087	4.9187	.008403361
120	14400	1728000	10.9545	4.9324	.008333333
121	14641	1771561	11	4.9461	.008264463
122	14884	1815848	11.0454	4.9597	.008196721
123	15129	1860867	11.0905	4.9732	.008130081
124	15376	1906624	11.1355	4.9866	.008064516
125	15625	1953125	11.1803	5	.008000000
126	15876	2000376	11.2250	5.0133	.007936508
127	16129	2048383	11.2694	5.0265	.007874016
128	16384	2097152	11.3137	5.0397	.007812500
129	16641	2146689	11.3578	5.0528	.007751938
130	16900	2197000	11.4018	5.0658	.007692308
131	17161	2248091	11.4455	5.0788	.007633588
132	17424	2299968	11.4891	5.0916	.007575758
133	17689	2352637	11.5326	5.1045	.007518797
134	17956	2406104	11.5758	5.1172	.007462687
135	18225	2460375	11.6190	5.1299	.007407407
136	18496	2515456	11.6619	5.1426	.007352941
137	18769	2571353	11.7047	5.1551	.007299270
138	19044	2628072	11.7473	5.1676	.007246377
139	19321	2685619	11.7898	5.1801	.007194245
140	19600	2744000	11.8322	5.1925	.007142857
141	19881	2803221	11.8743	5.2048	.007092199
142	20164	2863288	11.9164	5.2171	.007042254
143	20449	2924207	11.9583	5.2293	.006993007
144	20736	2985984	12	5.2415	.006944444
145	21025	3048625	12.0416	5.2536	.006896552
146	21316	3112136	12.0830	5.2656	.006849315
147	21609	3176523	12.1244	5.2776	.006802721
148	21904	3241792	12.1655	5.2896	.006756757
149	22201	3307949	12.2066	5.3015	.006711409
150	22500	3375000	12 2474	5.3133	.006666667
151	22801	3442951	12.2882	5.3251	006622517
152	23104	3511808	12.3288	5.3368	.006578947
153	23409	3581577	12.3693	5.3485	.006535948
154	23716	3652264	12.4097	5.3601	.006493506
155	24025	3723875	12.4499	5.3717	.006451613

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
156	24336	3796416	12.4900	5.3832	.006410256
157	24649	3869893	12.5300	5.3947	.006369427
158	24964	3944312	12.5698	5.4061	.006329114
159	25281	4019679	12.6095	5.4175	.006289308
160	25600	4096000	12.6491	5.4288	.006250000
161	25921	4173281	12.6886	5.4401	.006211180
162	26244	4251528	12.7279	5.4514	.006172840
163	26569	4330747	12.7671	5.4626	.006134969
164	26896	4410944	12.8062	5.4737	.006097561
165	27225	4492125	12.8452	5.4848	.006060606
166	27556	4574296	12.8841	5.4959	.006024096
167	27889	4657463	12.9228	5.5069	.005988024
168	28224	4741632	12.9615	5.5178	.005952381
169	28561	4826809	13	5.5288	.005917160
170	28900	4913000	13.0384	5.5397	.005882353
171	29241	5000211	13.0767	5.5505	.005847953
172	29584	5088448	13.1149	5.5613	.005813953
173	29929	5177717	13.1529	5.5721	.005780347
174	30276	5268024	13.1909	5.5828	.005747126
175	30625	5359375	13.2288	5.5934	.005714286
176	30976	5451776	13.2665	5.6041	.005681818
177	31329	5545233	13.3041	5.6147	.005649718
178	31684	5639752	13.3417	5.6252	.005617978
179	32041	5735339	13.3791	5.6357	.005586592
180	32400	5832000	13.4164	5.6462	.005555556
181	32761	5929741	13.4536	5.6567	.005524862
182	33124	6028568	13.4907	5.6671	.005494505
183	33489	6128487	13.5277	5.6774	.005464481
184	33856	6229504	13.5647	5.6877	.005434783
185	34225	6331625	13.6015	5.6980	.005405405
186	34596	6434856	13.6382	5.7083	.005376344
187	34969	6539203	13.6748	5.7185	.005347594
188	35344	6644672	13.7113	5.7287	.005319149
189	35721	6751269	13.7477	5.7388	.005291005
190	36100	6859000	13.7840	5.7489	.005263158
191	36481	6967871	13.8203	5.7590	.005235602
192	36864	7077888	13.8564	5.7690	.005208333
193	37249	7189057	13.8924	5.7790	.005181347
194	37636	7301384	13.9284	5.7890	.005154639
195	38025	7414875	13.9642	5.7989	.005128205

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
196	38416	7529536	14.0000	5.8088	.005102041
197	38809	7645373	14.0357	5.8186	.005076142
198	39204	7762392	14.0712	5.8285	.005050505
199	39601	7880599	14.1067	5.8383	.005025126
200	40000	8000000	14.1421	5.8480	.005000000
201	40401	8120601	14.1774	5.8578	.004975124
202	40804	8242408	14.2127	5.8675	.004950495
203	41209	8365427	14.2478	5.8771	.004926108
204	41616	8489664	14.2829	5.8868	.004901961
205	42025	8615125	14.3178	5.8964	.004878049
206	42436	8741816	14.3527	5.9059	.004854369
207	42849	8869743	14.3875	5.9155	.004830918
208	43264	8998912	14.4222	5.9250	.004807692
209	43681	9129329	14.4568	5.9345	.004784689
210	44100	9261000	14.4914	5.9439	.004761905
211	44521	9393931	14.5258	5.9533	.004739336
212	44944	9528128	14.5602	5.9627	.004716981
213	45369	9663597	14.5945	5.9721	.004694836
214	45796	9800344	14.6287	5.9814	.004672897
215	46225	9938375	14.6629	5.9907	.004651163
216	46656	10077696	14.6960	6	.004629630
217	47089	10218313	14.7309	6.0092	.004608295
218	47524	10360232	14.7648	6.0185	.004587156
219	47961	10503459	14.7986	6.0277	.004566210
220	48400	10648000	14.8324	6.0368	.004545455
221	48841	10793861	14.8661	6.0459	.004524887
222	49284	10941048	14.8997	6.0550	.004504505
223	49729	11089567	14.9332	6.0641	.004484305
224	50176	11239424	14.9666	6.0732	.004464286
225	50625	11390625	15	6.0822	.004444444
226	51076	11543176	15.0333	6.0912	.004424779
227	51529	11697083	15.0665	6.1002	.004405286
228	51984	11852352	15.0997	6.1091	.004385965
229	52441	12008989	15.1327	6.1180	.004366812
230	52900	12167000	15.1658	6.1269	.004347826
231	53361	12326391	15.1987	6.1358	.004329004
232	53824	12487168	15.2315	6.1446	.004310345
233	54289	12649337	15.2643	6.1534	.004291845
234	54756	12812904	15.2971	6.1622	.004273504
235	55225	12977875	15.3297	6.1710	.004255319

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
236	55696	13144256	15.3623	6.1797	.004237288
237	56169	13312053	15.3948	6.1885	.004219409
238	56644	13481272	15.4272	6.1972	.004201681
239	57121	13651919	15.4596	6.2058	.004184100
240	57600	13824000	15.4919	6.2145	.004166667
241	58081	13997521	15.5242	6.2231	.004149378
242	58564	14172488	15.5563	6.2317	.004132231
243	59049	14348907	15.5885	6.2403	.004115226
244	59536	14526784	15.6205	6.2488	.004098361
245	60025	14706125	15.6525	6.2573	.004081633
246	60516	14886936	15.6844	6.2658	.004065041
247	61009	15069223	15.7162	6.2743	.004048583
248	61504	15252992	15.7480	6.2828	.004032258
249	62001	15438249	15.7797	6.2912	.004016064
250	62500	15625000	15.8114	6.2996	.004000000
251	63001	15813251	15.8430	6.3080	.003984064
252	63504	16003008	15.8745	6.3164	.003968254
253	64009	16194277	15.9060	6.3247	.003952569
254	64516	16387064	15.9374	6.3330	.003937008
255	65025	16581375	15.9687	6.3413	.003921569
256	65536	16777216	16	6.3496	.003906250
257	66049	16974593	16.0312	6.3579	.003891051
258	66564	17173512	16.0624	6.3661	.003875969
259	67081	17373979	16.0935	6.3743	.003861004
260	67600	17576000	16.1245	6.3825	.003846154
261	68121	17779581	16.1555	6.3907	.003831418
262	68644	17984728	16.1864	6.3988	.003816794
263	69169	18191447	16.2173	6.4070	.003802281
264	69696	18399744	16.2481	6.4151	.003787879
265	70225	18609625	16.2788	6.4232	.003773585
266	70756	18821096	16.3095	6.4312	.003759398
267	71289	19034163	16.3401	6.4393	.003745318
268	71824	19248832	16.3707	6.4473	.003731343
269	72361	19465109	16.4012	6.4553	.003717472
270	72900	19683000	16.4317	6.4633	.003703704
271	73441	19902511	16.4621	6.4713	.003690037
272	73984	20123648	16.4924	6.4792	.003676471
273	74529	20346417	16.5227	6.4872	.003663004
274	75076	20570824	16.5529	6.4951	.003649635
275	75625	20796875	16.5831	6.5030	.003636364

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
276	76176	21024576	16.6132	6.5108	.003623188
277	76729	21253933	16.6433	6.5187	.003610108
278	77284	21484952	16.6733	6.5265	.003597122
279	77841	21717639	16.7033	6.5343	.003584229
280	78400	21952000	16.7332	6.5421	.003571429
281	78961	22188041	16.7631	6.5499	.003558719
282	79524	22425768	16.7929	6.5577	.003546099
283	80089	22665187	16.8226	6.5654	.003533569
284	80656	22906304	16.8523	6.5731	.003521127
285	81225	23149125	16.8819	6.5808	.003508772
286	81796	23393656	16.9115	6.5885	.003496503
287	82369	23639903	16.9411	6.5962	.003484321
288	82944	23887872	16.9706	6.6039	.003472222
289	83521	24137569	17	6.6115	.003460208
290	84100	24389000	17.0294	6.6191	.003448276
291	84681	24642171	17.0587	6.6267	.003436426
292	85264	24897088	17.0880	6.6343	.003424658
293	85849	25153757	17.1172	6.6419	.003412969
294	86436	25412184	17.1464	6.6494	.003401361
295	87025	25672375	17.1756	6.6569	.003389831
296	87616	25934336	17.2047	6.6644	.003378378
297	88209	26198073	17.2337	6.6719	.003367003
298	88804	26463592	17.2627	6.6794	.003355705
299	89401	26730899	17.2916	6.6869	.003344482
300	90000	27000000	17.3205	6.6943	.003333333
301	90601	27270901	17.3494	6.7018	.003322259
302	91204	27543608	17.4069	6.7166	.003311258
303	91809	27818127	17.3781	6.7092	.003300330
304	92416	28094464	17.4356	6.7240	.003289474
305	93025	28372625	17.4642	6.7313	.003278689
306	93636	28652616	17.4929	6.7387	.003267974
307	94249	28934443	17.5214	6.7460	.003257329
308	94864	29218112	17.5499	6.7533	.003246753
309	95481	29503629	17.5784	6.7606	.003236246
310	96100	29791000	17.6068	6.7679	.003225806
311	96721	30080231	17.6352	6.7752	.003215434
312	97344	30371328	17.6635	6.7824	.003205128
313	97969	30664297	17.6918	6 7897	.003194888
314	98596	30959144	17.7200	6.7969	.003184713
315	99225	31255875	17.7482	6.8041	.003174603

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
316	99856	31554496	17.7764	6.8113	.003164557
317	100489	31855013	17.8045	6.8185	.003154574
318	101124	32157432	17.8326	6.8256	.003144654
319	101761	32461759	17.8606	6.8328	.003134796
320	102400	32768000	17.8885	6.8399	.003125000
321	103041	33076161	17.9165	6.8470	.003115265
322	103684	33386248	17.9444	6.8541	.003105590
323	104329	33698267	17.9722	6.8612	.003095975
324	104976	34012224	18	6.8683	.003086420
325	105625	34328125	18.0278	6.8753	.003076923
326	106276	34645976	18.0555	6.8824	.003067485
327	106929	34965783	18.0831	6.8894	.003058104
328	107584	35287552	18.1108	6.8964	.003048780
329	108241	35611289	18.1384	6.9034	.003039514
330	108900	35937000	18.1659	6.9104	.003030303
331	109561	36264691	18.1934	6.9174	.003021148
332	110224	36594368	18.2209	6.9244	.003012048
333	110889	36926037	18.2483	6.9313	.003003003
334	111556	37259704	18.2757	6.9382	.002994012
335	112225	37595375	18.3030	6.9451	.002985075
336	112896	37933056	18.3303	6.9521	.002976190
337	113569	38272753	18.3576	6.9589	.002967359
338	114244	38614472	18.3848	6.9658	.002958580
339	114921	38958219	18.4120	6.9727	.002949853
340	115600	39304000	18.4391	6.9795	.002941176
341	116281	39651821	18.4662	6.9864	.002932551
342	116964	40001688	18.4932	6.9932	.002923977
343	117649	40353607	18.5203	7	.002915452
344	118336	40707584	18.5472	7.0068	.002906977
345	119025	41063625	18.5742	7.0136	.002898551
346	119716	41421736	18.6011	7.0203	.002890173
347	120409	41781923	18.6279	7.0271	.002881844
348	121104	42144192	18.6548	7.0338	.002873563
349	121801	42508549	18.6815	7.0406	.002865330
350	122500	42875000	18.7083	7.0473	.002857143
351	123201	43243551	18.7350	7.0540	.002849003
352	123904	43614208	18.7617	7.0607	.002840909
353	124609	43986977	18.7883	7.0674	.002832861
354	125316	44361864	18.8149	7.0740	.002824859
355	126025	44738875	18.8414	7.0807	.002816901

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
356	126736	45118016	18.8680	7.0873	.002808989
357	127449	45499293	18.8944	7.0940	.002801120
358	128164	45882712	18.9209	7.1006	.002793296
359	128881	46268279	18.9473	7.1072	.002785515
360	129600	46656000	18.9737	7.1138	.002777778
361	130321	47045881	19	7.1204	.002770083
362	131044	47437928	19.0263	7.1269	.002762431
363	131769	47832147	19.0526	7.1335	.002754821
364	132496	48228544	19.0788	7.1400	.002747253
365	133225	48627125	19.1050	7.1466	.002739726
366	133956	49027896	19.1311	7.1531	.002732240
367	134689	49430863	19.1572	7.1596	.002724796
368	135424	49836032	19.1833	7.1661	.002717391
369	136161	50243409	19.2094	7.1726	.002710027
370	136900	50653000	19.2354	7.1791	.002702703
371	137641	51064811	19.2614	7.1855	.002695418
372	138384	51478848	19.2873	7.1920	.002688172
373	139129	51895117	19.3132	7.1984	.002680965
374	139876	52313624	19.3391	7.2048	.002673797
375	140625	52734375	19.3649	7.2112	.002666667
376	141376	53157376	19.3907	7.2177	.002659574
377	142129	53582633	19.4165	7.2240	.002652520
378	142884	54010152	19.4422	7.2304	.002645503
379	143641	54439939	19.4679	7.2368	.002638522
380	144400	54872000	19.4936	7.2432	.002631579
381	145161	55306341	19.5192	7.2495	.002624672
382	145924	55742968	19.5448	7.2558	.002617801
383	146689	56181887	19.5704	7.2622	.002610966
384	147456	56623104	19.5959	7.2685	.002604167
385	148225	57066625	19.6214	7.2748	.002597403
386	148996	57512456	19.6469	7.2811	.002590674
387	149769	57960603	19.6723	7.2874	.002583979
388	150544	58411072	19.6977	7.2936	.002577320
389	151321	58863869	19.7231	7.2999	.002570694
390	152100	59319000	19.7484	7.3061	.002564103
391	152881	59776471	19.7737	7.3124	.002557545
392	153664	60236288	19.7990	7.3186	.002551020
393	154449	60698457	19.8242	7.3248	.002544529
394	155236	61162984	19.8494	7.3310	.002538071
395	156025	61629875	19.8746	7.3372	.002531646

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
396	156816	62099136	19.8997	7.3434	.002525253
397	157609	62570773	19.9249	7.3496	.002518892
398	158404	63044792	19.9499	7.3558	.002512563
399	159201	63521199	19.9750	7.3619	.002506266
400	160000	64000000	20	7 3681	.002500000
401	160801	64481201	20.0250	7 3742	.002493766
402	161604	64964808	20.0499	7.3803	.002487562
403	162409	65450827	20.0749	7.3864	.002481390
404	163216	65939264	20.0998	7.3925	.002475248
405	164025	66430125	20.1246	7.3986	.002469136
406	164836	66923416	20.1494	7.4047	.002463054
407	165649	67419143	20.1742	7.4108	.002457002
408	166464	67917312	20.1990	7.4169	.002450980
409	167281	68417929	20.2237	7.4229	.002444988
410	168100	68921000	20.2485	7.4290	.002439024
411	168921	69426531	20.2731	7.4350	.002433090
412	169744	69934528	20.2978	7.4410	.002427184
413	170569	70444997	20.3224	7.4470	.002421308
414	171396	70957944	20.3470	7.4530	.002415459
415	172225	71473375	20.3715	7.4590	.002409639
416	173056	71991296	20.3961	7.4650	.002403846
417	173889	72511713	20.4206	7.4710	.002398082
418	174724	73034632	20.4450	7.4770	.002392344
419	175561	73560059	20.4695	7.4829	.002386635
420	176400	74088000	20.4939	7.4889	.002380952
421	177241	74618461	20.5183	7.4948	.002375297
422	178084	75151448	20.5426	7.5007	.002369668
423	178929	75686967	20.5670	7.5067	.002364066
424	179776	76225024	20.5913	7.5126	.002358491
425	180625	76765625	20.6155	7.5185	.002352941
426	181476	77308776	20.6398	7.5244	.002347418
427	182329	77854483	20.6640	7.5302	.002341920
428	183184	78402752	20.6882	7.5361	.002336449
429	184041	78953589	20.7123	7.5420	.002331002
430	184900	79507000	20.7364	7.5478	.002325581
431	185761	80062991	20.7605	7.5537	.002320186
432	186624	80621568	20.7846	7.5595	.002314815
433	187489	81182737	20.8087	7.5654	.002309469
434	188356	81746504	20.8327	7.5712	.002304147
435	189225	82312875	20.8567	7.5770	.002298851

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
436	190096	82881856	20.8806	7.5828	.002293578
437	190969	83453453	20.9045	7.5886	.002288330
438	191844	84027672	20.9284	7.5944	.002283105
439	192721	84604519	20.9523	7.6001	.002277904
440	193600	85184000	20.9762	7.6059	.002272727
441	194481	85766121	21	7.6117	.002267574
442	195364	86350888	21.0238	7.6174	.002262443
443	196249	86938307	21.0476	7.6232	.002257336
444	197136	87528384	21.0713	7.6289	.002252252
445	198025	88121125	21.0950	7.6346	.002247191
446	198916	88716536	21.1187	7.6403	.002242152
447	199809	89314623	21.1424	7.6460	.002237136
448	200704	89915392	21.1660	7.6517	.002232143
449	201601	90518849	21.1896	7.6574	.002227171
450	202500	91125000	21.2132	7.6631	.002222222
451	203401	91733851	21.2368	7.6688	.002217295
452	204304	92345408	21.2603	7.6744	.002212389
453	205209	92959677	21.2838	7.6801	.002207506
454	206116	93576664	21.3073	7.6857	.002202643
455	207025	94196375	21.3307	7.6914	.002197802
456	207936	94818816	21.3542	7.6970	.002192982
457	208849	95443993	21.3776	7.7026	.002188184
458	209764	96071912	21.4009	7.7082	.002183406
459	210681	96702579	21.4243	7.7138	.002178649
460	211600	97336000	21.4476	7.7194	.002173913
461	212521	97972181	21.4709	7.7250	.002169197
462	213444	98611128	21.4942	7.7306	.002164502
463	214369	99252847	21.5174	7.7362	.002159827
464	215296	99897344	21.5407	7.7418	.002155172
465	216225	100544625	21.5639	7.7473	.002150538
466	217156	101194696	21.5870	7.7529	.002145923
467	218089	101847563	21.6102	7.7584	.002141328
468	219024	102503232	21.6333	7.7639	.002136752
469	219961	103161709	21.6564	7.7695	.002132196
470	220900	103823000	21.6795	7.7750	.002127660
471	221841	104487111	21.7025	7.7805	.002123142
472	222784	105154048	21.7256	7.7860	.002118644
473	223729	105823817	21.7486	7.7915	.002114165
474	224676	106496424	21.7715	7.7970	.002109705
475	225625	107171875	21.7945	7.8025	.002105263

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
476	226576	107850176	21.8174	7.8079	.002100840
477	227529	108531333	21.8403	7.8134	.002096436
478	228484	109215352	21.8632	7.8188	.002092050
479	229441	109902239	21.8861	7.8243	.002087683
480	230400	110592000	21.9089	7.8297	.002083333
481	231361	111284641	21.9317	7.8352	.002079002
482	232324	111980168	21.9545	7.8406	.002074689
483	233289	112678587	21.9773	7.8460	.002070393
484	234256	113379904	22	7.8514	.002066116
485	235225	114084125	22.0227	7.8568	.002061856
486	236196	114791256	22.0454	7.8622	.002057613
487	237169	115501303	22.0681	7.8676	.002053388
488	238144	116214272	22.0907	7.8730	.002049180
489	239121	116930169	22.1133	7.8784	.002044990
490	240100	117649000	22.1359	7.8837	.002040816
491	241081	118370771	22.1585	7.8891	.002036660
492	242064	119095488	22.1811	7.8944	.002032520
493	243049	119823157	22.2036	7.8998	.002028398
494	244036	120553784	22.2261	7.9051	.002024291
495	245025	121287375	22.2486	7.9105	.002020202
496	246016	122023936	22.2711	7.9158	.002016129
497	247009	122763473	22.2935	7.9211	.002012072
498	248004	123505992	22.3159	7.9264	.002008032
499	249001	124251499	22.3383	7.9317	.002004008
500	250000	125000000	22.3607	7.9370	.002000000
501	251001	125751501	22.3830	7.9423	.001996008
502	252004	126506008	22.4054	7.9476	.001992032
503	253009	127263527	22.4277	7.9528	.001988072
504	254016	128024064	22.4499	7.9581	.001984127
505	255025	128787625	22.4722	7.9634	.001980198
506	256036	129554216	22.4944	7.9686	.001976285
507	257049	130323843	22.5167	7.9739	.001972387
508	258064	131096512	22.5389	7.9791	.001968504
509	259081	131872229	22.5610	7.9843	.001964637
510	260100	132651000	22.5832	7.9896	.001960784
511	261121	133432831	22.6053	7.9948	.001956947
512	262144	134217728	22.6274	8	.001953125
513	263169	135005697	22.6495	8.0052	.001949318
514	264196	135796744	22.6716	8.0104	.0019455
515	265225	136590875	22.6936	8.0156	.001941

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
516	266256	137388096	22.7156	8.0208	.001937984
517	267289	138188413	22.7376	8.0260	.001934236
518	268324	138991832	22.7596	8.0311	.001930502
519	269361	139798359	22 7816	8.0363	.001926782
520	270400	140608000	22.8035	8.0415	.001923077
521	271441	141420761	22.8254	8.0466	.001919386
522	272484	142236648	22.8473	8.0517	.001915709
523	273529	143055667	22.8692	8.0569	.001912046
524	274576	143877824	22.8910	8.0620	.001908397
525	275625	144703125	22.9129	8.0671	.001904762
526	276676	145531576	22.9347	8.0723	.001901141
527	277729	146363183	22.9565	8.0774	.001897533
528	278784	147197952	22.9783	8.0825	.001893939
529	279841	148035889	23	8.0876	.001890359
530	280900	148877000	23.0217	8.0927	.001886792
531	281961	149721291	23.0434	8.0978	.001883239
532	283024	150568768	23.0651	8.1028	.001879699
533	284089	151419437	23.0868	8.1079	.001876173
534	285156	152273304	23.1084	8.1130	.001872659
535	286225	153130375	23.1301	8.1180	.001869159
536	287296	153990656	23.1517	8.1231	.001865672
537	288369	154854153	23.1733	8.1281	.001862197
538	289444	155720872	23.1948	8.1332	.001858736
539	290521	156590819	23.2164	8.1382	.001855288
540	291600	157464000	23.2379	8.1433	.001851852
541	292681	158340421	23.2594	8.1483	.001848429
542	293764	159220088	23.2809	8.1533	.001845018
543	294849	160103007	23.3024	8.1583	.001841621
544	295936	160989184	23.3238	8.1633	.001838235
545	297025	161878625	23.3452	8.1683	.001834862
546	298116	162771336	23.3666	8.1733	.001831502
547	299209	163667323	23.3880	8.1783	.001828154
548	300304	164566592	23.4094	8.1833	.001824818
549	301401	165469149	23.4307	8.1882	.001821494
550	302500	166375000	23.4521	8.1932	.001818182
551	303601	167284151	23.4734	8.1982	.001814882
552	304704	168196608	23.4947	8.2031	.001811594
553	305809	169112377	23.5160	8.2081	.001808318
554	306916	170031464	23.5372	8.2130	.001805054
555	308025	170953875	23.5584	8.2180	.001801802

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocals.
556	309136	171879616	23.5797	8.2229	.001798561
557	310249	172808693	23.6008	8.2278	.001795332
558	311364	173741112	23.6220	8.2327	.001792115
559	312481	174676879	23.6432	8.2377	.001788909
560	313600	175616000	23.6643	8.2426	.001785714
561	314721	176558481	23.6854	8.2475	.001782531
562	315844	177504328	23.7065	8.2524	.001779359
563	316969	178453547	23.7276	8.2573	.001776199
564	318096	179406144	23.7487	8.2621	.001773050
565	319225	180362125	23.7697	8.2670	.001769912
566	320356	181321496	23.7908	8.2719	.001766784
567	321489	182284263	23.8118	8.2768	.001763668
568	322624	183250432	23.8328	8.2816	.001760563
569	323761	184220009	23.8537	8.2865	.001757469
570	324900	185193000	23.8747	8 2913	.001754386
571	326041	186169411	23.8956	8.2962	.001751313
572	327184	187149248	23.9165	8 3010	.001748252
573	328329	188132517	23.9374	8.3059	.001745201
574	329476	189119224	23.9583	8.3107	.001742160
575	330625	190109375	23.9792	8.3155	.001739130
576	331776	191102976	24	8.3203	.001736111
577	332929	192100033	24.0208	8.3251	.001733102
578	334084	193100552	24.0416	8.3300	.001730104
579	335241	194104539	24.0624	8.3348	.001727116
580	336400	195112000	24.0832	8.3396	.001724138
581	337561	196122941	24.1039	8.3443	.001721170
582	338724	197137368	24.1247	8.3491	.001718213
583	339889	198155287	24.1454	8.3539	.001715266
584	341056	199176704	24.1661	8.3587	.001712329
585	342225	200201625	24.1868	8.3634	.001709402
586	343396	201230056	24.2074	8.3682	.001706485
587	344569	202262003	24.2281	8.3730	.001703578
588	345744	203297472	24.2487	8.3777	.001700680
589	346921	204336469	24.2693	8.3825	.001697793
590	348100	205379000	24.2899	8.3872	.001694915
591	349281	206425071	24.3105	8.3919	.001692047
592	350464	207474688	24 3311	8.3967	.001689189
593	351649	208527857	24 3516	8.4014	.001686341
594	352836	209584584	24.3721	8.4061	.001683502
595	354025	210644875	24.3926	8.4108	.001680672

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
596	355216	211708736	24.4131	8.4155	.001677852
597	356409	212776173	24.4336	8.4202	.001675042
598	357604	213847192	24.4540	8.4249	.001672241
599	358801	214921799	24.4745	8.4296	.001669449
600	360000	216000000	24.4949	8.4343	.001666667
601	361201	217081801	24.5153	8.4390	.001663894
602	362404	218167208	24.5357	8.4437	.001661130
603	363609	219256227	24.5561	8.4484	.001658375
604	364816	220348864	24.5764	8 4530	.001655629
605	366025	221445125	24.5967	8.4577	.001652893
606	367236	222545016	24.6171	8.4623	.001650165
607	368449	223648543	24.6374	8.4670	.001647446
608	369664	224755712	24.6577	8.4716	.001644737
609	370881	225866529	24.6779	8.4763	.001642036
610	372100	226981000	24.6982	8.4809	.001639344
611	373321	228099131	24.7184	8.4856	.001636661
612	374544	229220928	24.7386	8.4902	.001633987
613	375769	230346397	24.7588	8.4948	.001631321
614	376996	231475544	24.7790	8.4994	.001628664
615	378225	232608375	24.7992	8.5040	.001626016
616	379456	233744896	24.8193	8.5086	.001623377
617	380689	234885113	24.8395	8.5132	.001620746
618	381924	236029032	24.8596	8.5178	.001618123
619	383161	237176659	24.8797	8.5224	.001615509
620	384400	238328000	24.8998	8.5270	.001612903
621	385641	239483061	24.9199	8.5316	.001610306
622	386884	240641848	24.9399	8.5362	.001607717
623	388129	241804367	24.9600	8.5408	.001605136
624	389376	242970624	24.9800	8.5453	.001602564
625	390625	244140625	25	8.5499	.001600000
626	391876	245314376	25.0200	8.5544	.001597444
627	393129	246491883	25.0400	8.5590	.001594896
628	394384	247673152	25 0599	8.5635	.001592357
629	395641	248858189	25.0799	8.5681	.001589825
630	396900	250047000	25.0998	8.5726	.001587302
631	398161	251239591	25.1197	8.5772	.001584786
632	399424	252435968	25.1396	8.5817	.001582278
633	400689	253636137	25.1595	8.5862	.001579779
634	401956	254840104	25.1794	8.5907	.001577287
635	403225	256047875	25.1992	8.5952	.001574803

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
636	404496	257259456	25.2190	8.5997	.001572327
637	405769	258474853	25.2389	8.6043	.001569859
638	407044	259694072	25.2587	8.6088	.001567398
639	408321	260917119	25.2784	8.6132	.001564945
640	409600	262144000	25.2982	8.6177	.001562500
641	410881	263374721	25.3180	8.6222	.001560062
642	412164	264609288	25.3377	8.6267	.001557632
643	413449	265847707	25.3574	8.6312	.001555210
644	414736	267089984	25.3772	8.6357	.001552795
645	416025	268336125	25.3969	8.6401	.001550388
646	417316	269586136	25.4165	8.6446	.001547988
647	418609	270840023	25.4362	8.6490	.001545595
648	419904	272097792	25.4558	8.6535	.001543210
649	421201	273359449	25.4755	8.6579	.001540832
650	422500	274625000	25.4951	8.6624	.001538462
651	423801	275894451	25.5147	8.6668	.001536098
652	425104	277167808	25.5343	8.6713	.001533742
653	426409	278445077	25.5539	8.6757	.001531394
654	427716	279726264	25.5734	8.6801	.001529052
655	429025	281011375	25.5930	8.6845	.001526718
656	430336	282300416	25.6125	8.6890	.001524390
657	431649	283593393	25.6320	8.6934	.001522070
658	432964	284890312	25 6515	8.6978	.001519757
659	434281	286191179	25.6710	8.7022	.001517451
660	435600	287496000	25.6905	8.7066	.001515152
661	436921	288804781	25.7099	8.7110	.001512859
662	438244	290117528	25.7294	8.7154	.001510574
663	439569	291434247	25.7488	8.7198	.001508296
664	440896	292754944	25.7682	8.7241	.001506024
665	442225	294079625	25.7876	8.7285	.001503759
666	443556	295408296	25.8070	8.7329	.001501502
667	444889	296740963	25.8263	8.7373	.001499250
668	446224	298077632	25.8457	8.7416	.001497006
669	447561	299418309	25.8650	8.7460	.001494768
670	448900	300763000	25.8844	8.7503	.001492537
671	450241	302111711	25.9037	8.7547	.001490313
672	451584	303464448	25.9230	8.7590	.001488095
673	452929	304821217	25.9422	8.7634	.001485884
674	454276	306182024	25.9615	8.7677	.001483680
675	455625	307546875	25.9808	8.7721	.001481481

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
676	456976	308915776	26	8.7764	.001479290
677	458329	310288733	26.0192	8.7807	.001477105
678	459684	311665752	26.0384	8.7850	.001474926
679	461041	313046839	26.0576	8.7893	.001472754
680	462400	314432000	26.0768	8.7937	.001470588
681	463761	315821241	26.0960	8.7980	.001468429
682	465124	317214568	26.1151	8.8023	.001466276
683	466489	318611987	26.1343	8.8066	.001464129
684	467856	320013504	26.1534	8.8109	.001461988
685	469225	321419125	26.1725	8.8152	.001459854
686	470596	322828856	26.1916	8.8194	.001457726
687	471969	324242703	26.2107	8.8237	.001455604
688	473344	325660672	26.2298	8.8280	.001453488
689	474721	327082769	26.2488	8.8323	.001451379
690	476100	328509000	26.2679	8.8366	.001449275
691	477481	329939371	26.2869	8.8408	.001447178
692	478864	331373888	26.3059	8.8451	.001445087
693	480249	332812557	26.3249	8.8493	.001443001
694	481636	334255384	26.3439	8.8536	.001440922
695	483025	335702375	26.3629	8.8578	.001438849
696	484416	337153536	26.3818	8.8621	.001436782
697	485809	338608873	26.4008	8.8663	.001434720
698	487204	340068392	26.4197	8.8706	.001432665
699	488601	341532099	26.4386	8.8748	.001430615
700	490000	343000000	26.4575	8.8790	.001428571
701	491401	344472101	26.4764	8.8833	.001426534
702	492804	345948408	26.4953	8.8875	.001424501
703	494209	347428927	26.5141	8.8917	.001422475
704	495616	348913664	26.5330	8.8959	.001420455
705	497025	350402625	26.5518	8.9001	.001418440
706	498436	351895816	26.5707	8.9043	.001416431
707	499849	353393243	26.5895	8.9085	.001414427
708	501264	354894912	26.6083	8.9127	.001412429
709	502681	356400829	26.6271	8.9169	.001410437
710	504100	357911000	26.6458	8.9211	.001408451
711	505521	359425431	26.6646	8.9253	.001406470
712	506944	360944128	26.6833	8.9295	.001404494
713	508369	362467097	26.7021	8.9337	.001402525
714	509796	363994344	26.7208	8.9378	.001400560
715	511225	365525875	26.7395	8.9420	.001398601

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
716	512656	367061696	26.7582	8.9462	.001396648
717	514089	368601813	26.7769	8.9503	.001394700
718	515524	370146232	26.7955	8.9545	.001392758
719	516961	371694959	26.8142	8.9587	.001390821
720	518400	373248000	26.8328	8.9628	.001388889
721	519841	374805361	26.8514	8.9670	.001386963
722	521284	376367048	26.8701	8.9711	.001385042
723	522729	377933067	26.8887	8.9752	.001383126
724	524176	379503424	26.9072	8.9794	.001381215
725	525625	381078125	26.9258	8.9835	.001379310
726	527076	382657176	26.9444	8.9876	.001377410
727	528529	384240583	26.9629	8.9918	.001375516
728	529984	385828352	26.9815	8.9959	.001373626
729	531441	387420489	27	9	.001371742
730	532900	389017000	27.0185	9.0041	.001369863
731	534361	390617891	27.0370	9.0082	.001367989
732	535824	392223168	27.0555	9.0123	.001366120
733	537289	393832837	27.0740	9.0164	.001364256
734	538756	395446904	27.0924	9.0205	.001362398
735	540225	397065375	27.1109	9.0246	.001360544
736	541696	398688256	27.1293	9.0287	.001358696
737	543169	400315553	27.1477	9.0328	.001356852
738	544644	401947272	27.1662	9.0369	.001355014
739	546121	403583419	27.1846	9.0410	.001353180
740	547600	405224000	27.2029	9.0450	.001351351
741	549081	406869021	27.2213	9.0491	.001349528
742	550564	408518488	27.2397	9.0532	.001347709
743	552049	410172407	27.2580	9.0572	.001345895
744	553536	411830784	27.2764	9.0613	.001344086
745	555025	413493625	27.2947	9.0654	.001342282
746	556516	415160936	27.3130	9.0694	.001340483
747	558009	416832723	27.3313	9.0735	.001338688
748	559504	418508992	27.3496	9.0775	.001336898
749	561001	420189749	27.3679	9.0816	.001335113
750	562500	421875000	27.3861	9.0856	.001333333
751	564001	423564751	27.4044	9.0896	.001331558
752	565504	425259008	27.4226	9.0937	.001329787
753	567009	426957777	27.4408	9.0977	.001328021
754	568516	428661064	27.4591	9.1017	.001326260
755	570025	430368875	27.4773	9.1057	.001324503

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
756	571536	432081216	27.4955	9.1098	.001322751
757	573049	433798093	27.5136	9.1138	.001321004
758	574564	435519512	27.5318	9.1178	.001319261
759	576081	437245479	27.5500	9.1218	.001317523
760	577600	438976000	27.5681	9.1258	.001315789
761	579121	440711081	27.5862	9.1298	.001314060
762	580644	442450728	27.6043	9.1338	.001312336
763	582169	444194947	27.6225	9.1378	.001310616
764	583696	445943744	27.6405	9.1418	.001308901
765	585225	447697125	27.6586	9.1458	.001307190
766	586756	449455096	27.6767	9.1498	.001305483
767	588289	451217663	27.6948	9.1537	.001303781
768	589824	452984832	27.7128	9.1577	.001302083
769	591361	454756609	27.7308	9.1617	.001300390
770	592900	456533000	27.7489	9.1657	.001298701
771	594441	458314011	27.7669	9.1696	.001297017
772	595984	460099648	27.7849	9.1736	.001295337
773	597529	461889917	27.8029	9.1775	.001293661
774	599076	463684824	27.8209	9.1815	.001291990
775	600625	465484375	27.8388	9.1855	.001290323
776	602176	467288576	27.8568	9.1894	.001288660
777	603729	469097433	27.8747	9.1933	.001287001
778	605284	470910952	27.8927	9.1973	.001285347
779	606841	472729139	27.9106	9.2012	.001283697
780	608400	474552000	27.9285	9.2052	.001282051
781	609961	476379541	27.9464	9.2091	.001280410
782	611524	478211768	27.9643	9.2130	.001278772
783	613089	480048687	27.9821	9.2170	.001277139
784	614656	481890304	28	9.2209	.001275510
785	616225	483736625	28.0179	9.2248	.001273885
786	617796	485587656	28.0357	9.2287	.001272265
787	619369	487443403	28.0535	9.2326	.001270648
788	620944	489303872	28.0713	9.2365	.001269036
789	622521	491169069	28.0891	9.2404	.001267427
790	624100	493039000	28.1069	9.2443	.001265823
791	625681	494913671	28.1247	9.2482	.001264223
792	627264	496793088	28.1425	9.2521	.001262626
793	628849	498677257	28.1603	9.2560	.001261034
794	630436	500566184	28.1780	9.2599	.001259446
795	632025	502459875	28.1957	9.2638	.001257862

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
796	633616	504358336	28.2135	9.2677	.001256281
797	635209	506261573	28.2312	9.2716	.001254705
798	636804	508169592	28.2489	9.2754	.001253133
799	638401	510082399	28.2666	9.2793	.001251564
800	640000	512000000	28.2843	9.2832	.001250000
801	641601	513922401	28.3019	9.2870	.001248439
802	643204	515849608	28.3196	9.2909	.001246883
803	644809	517781627	28.3373	9.2948	.001245330
804	646416	519718464	28.3549	9.2986	.001243781
805	648025	521660125	28.3725	9.3025	.001242236
806	649636	523606616	28.3901	9.3063	.001240695
807	651249	525557943	28.4077	9.3102	.001239157
808	652864	527514112	28.4253	9.3140	.001237624
809	654481	529475129	28.4429	9.3179	.001236094
810	656100	531441000	28.4605	9.3217	.001234568
811	657721	533411731	28.4781	9.3255	.001233046
812	659344	535387328	28.4956	9.3294	.001231527
813	660969	537367797	28.5132	9.3332	.001230012
814	662596	539353144	28.5307	9.3370	.001228501
815	664225	541343375	28.5482	9.3408	.001226994
816	665856	543338496	28.5657	9.3447	.001225490
817	667489	545338513	28.5832	9.3485	.001223990
818	669124	547343432	28.6007	9.3523	.001222494
819	670761	549353259	28.6182	9.3561	.001221001
820	672400	551368000	28.6356	9.3599	.001219512
821	674041	553387661	28.6531	9.3637	.001218027
822	675684	555412248	28.6705	9.3675	.001216545
823	677329	557441767	28.6880	9.3713	.001215067
824	678976	559476224	28.7054	9.3751	.001213592
825	680625	561515625	28.7228	9.3789	.001212121
826	682276	563559976	28.7402	9.3827	.001210654
827	683929	565609283	28.7576	9.3865	.001209190
828	685584	567663552	28.7750	9.3902	.001207729
829	687241	569722789	28.7924	9.3940	.001206273
830	688900	571787000	28.8097	9.3978	.001204819
831	690561	573856191	28.8271	9.4016	.001203369
832	692224	575930368	28.8444	9.4053	.001201923
833	693889	578009537	28.8617	9.4091	.001200480
834	695556	580093704	28.8791	9.4129	.001199041
835	697225	582182875	28.8964	9.4166	.00119760

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
836	698896	584277056	28.9137	9.4204	.001196172
837	700569	586376253	28.9310	9.4241	.001194743
838	702244	588480472	28.9482	9.4279	.001193317
839	703921	590589719	28.9655	9.4316	.001191895
840	705600	592704000	28.9828	9.4354	.001190476
841	707281	594823321	29	9.4391	.001189061
842	708964	596947688	29.0172	9.4429	.001187648
843	710649	599077107	29.0345	9.4466	.001186240
844	712336	601211584	29.0517	9.4503	.001184834
845	714025	603351125	29.0689	9.4541	.001183432
846	715716	605495736	29.0861	9.4578	.001182033
847	717409	607645423	29.1033	9.4615	.001180638
848	719104	609800192	29.1204	9.4652	.001179245
849	720801	611960049	29.1376	9.4690	.001177856
850	722500	614125000	29.1548	9.4727	.001176471
851	724201	616295051	29.1719	9.4764	.001175088
852	725904	618470208	29.1890	9.4801	.001173709
853	727609	620650477	29.2062	9.4838	.001172333
854	729316	622835864	29.2233	9.4875	.001170960
855	731025	625026375	29.2404	9.4912	.001169591
856	732736	627222016	29.2575	9.4949	.001168224
857	734449	629422793	29.2746	9.4986	.001166861
858	736164	631628712	29.2916	9.5023	.001165501
859	737881	633839779	29.3087	9.5060	.001164144
860	739600	636056000	29.3258	9.5097	.001162791
861	741321	638277381	29.3428	9.5134	.001161440
862	743044	640503928	29.3598	9.5171	.001160093
863	744769	642735647	29.3769	9.5207	.001158749
864	746496	644972544	29.3939	9.5244	.001157407
865	748225	647214625	29.4109	9.5281	.001156069
866	749956	649461896	29.4279	9.5317	.001154734
867	751689	651714363	29.4449	9.5354	.001153403
868	753424	653972032	29.4618	9.5391	.001152074
869	755161	656234909	29.4788	9.5427	.001150748
870	756900	658503000	29.4958	9.5464	.001149425
871	758641	660776311	29.5127	9.5501	.001148106
872	760384	663054848	29.5296	9.5537	.001146789
873	762129	665338617	29.5466	9.5574	.001145475
874	763876	667627624	29.5635	9.5610	.001144165
875	765625	669921875	29.5804	9.5647	.001142857

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
876	767376	672221376	29.5973	9.5683	.001141553
877	769129	674526133	29.6142	9.5719	.001140251
878	770884	676836152	29.6311	9.5756	.001138952
879	772641	679151439	29.6479	9.5792	.001137656
880	774400	681472000	29.6648	9.5828	.001136364
881	776161	683797841	29.6816	9.5865	.001135074
882	777924	686128968	29.6985	9.5901	.001133787
883	779689	688465387	29.7153	9.5937	.001132503
884	781456	690807104	29.7321	9.5973	.001131222
885	783225	693154125	29.7489	9.6010	.001129944
886	784996	695506456	29.7658	9.6046	.001128668
887	786769	697864103	29.7825	9.6082	.001127396
888	788544	700227072	29.7993	9.6118	.001126126
889	790321	702595369	29.8161	9.6154	.001124859
890	792100	704969000	29.8329	9.6190	.001123596
891	793881	707347971	29.8496	9.6226	.001122334
892	795664	709732288	29.8664	9.6262	.001121076
893	797449	712121957	29.8831	9.6298	.001119821
894	799236	714516984	29.8998	9.6334	.001118568
895	801025	716917375	29.9166	9.6370	.001117318
896	802816	719323136	29.9333	9.6406	.001116071
897	804609	721734273	29.9500	9.6442	.001114782
898	806404	724150792	29.9666	9.6477	.001113586
899	808201	726572699	29.9833	9.6513	.001112347
900	810000	729000000	30	9.6549	.001111111
901	811801	731432701	30.0167	9.6585	.001109878
902	813604	733870808	30.0333	9.6620	.001108647
903	815409	736314327	30.0500	9.6656	.001107420
904	817216	738763264	30.0666	9.6692	.001106195
905	819025	741217625	30.0832	9.6727	.001104972
906	820836	743677416	30.0998	9.6763	.001103753
907	822649	746142643	30.1164	9.6799	.001102536
908	824464	748613312	30.1330	9.6834	.001101322
909	826281	751089429	30.1496	9.6870	.001100110
910	828100	753571000	30.1662	9.6905	.001098901
911	829921	756058031	30.1828	9.6941	.001097695
912	831744	758550528	30.1993	9.6976	.001096491
913	833569	761048497	30.2159	9.7012	.001095290
914	835396	763551944	30.2324	9.7047	.0010940
915	837225	766060875	30.2490	9.7082	.0010928

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
916	839056	768575296	30.2655	9.7118	.001091703
917	840889	771095213	30.2820	9.7153	.001090513
918	842724	773620632	30.2985	9.7188	.001089325
919	844561	776151559	30.3150	9.7224	.001088139
920	846400	778688000	30.3315	9.7259	.001086957
921	848241	781229961	30.3480	9.7294	.001085776
922	850084	783777448	30.3645	9.7329	.001084599
923	851929	786330467	30.3809	9.7364	.001083423
924	853776	788889024	30.3974	9.7400	.001082251
925	855625	791453125	30.4138	9.7435	.001081081
926	857476	794022776	30.4302	9.7470	.001079914
927	859329	796597983	30.4467	9.7505	.001078749
928	861184	799178752	30.4631	9.7540	.001077586
929	863041	801765089	30.4795	9.7575	.001076426
930	864900	804357000	30.4959	9.7610	.001075269
931	866761	806954491	30.5123	9.7645	.001074114
932	868624	809557568	30.5287	9.7680	.001072961
933	870489	812166237	30.5450	9.7715	.001071811
934	872356	814780504	30.5614	9.7750	.001070664
935	874225	817400375	30.5778	9.7785	.001069519
936	876096	820025856	30.5941	9.7819	.001068376
937	877969	822656953	30.6105	9 7854	.001067236
938	879844	825293672	30.6268	9 7889	.001066098
939	881721	827936019	30.6431	9.7924	.001064963
940	883600	830584000	30.6594	9.7959	.001063830
941	885481	833237621	30.6757	9.7993	.001062699
942	887364	835896888	30.6920	9.8028	.001061571
943	889249	838561807	30.7083	9.9063	.001060445
944	891136	841232384	30.7246	9.8097	.001059322
945	893025	843908625	30.7409	9.8132	.001058201
946	894916	846590536	30.7571	9.8167	.001057082
947	896809	849278123	30.7734	9.8201	.001055966
948	898704	851971392	30.7896	9.8236	.001054852
949	900601	854670349	30.8058	9.8270	.001053741
950	902500	857375000	30.8221	9.8305	.001052632
951	904401	860085351	30.8383	9.8339	.001051525
952	906304	862801408	30.8545	9.8374	.001050420
953	908209	865523177	30.8707	9.8408	.001049318
954	910116	868250664	30.8869	9.8443	.001048218
955	912025	870983875	30.9031	9.8477	.001047120

SQUARES, CUBES, SQUARE ROOTS, ETC.—*Cont.*

No.	Square.	Cube.	Sq. Rt.	C. Rt.	Reciprocal.
956	913936	873722816	30.9192	9.8511	.001046025
957	915849	876467493	30.9354	9.8546	.001044932
958	917764	879217912	30.9516	9.8580	.001043841
959	919681	881974079	30.9677	9.8614	.001042753
960	921600	884736000	30.9839	9.8648	.001041667
961	923521	887503681	31	9.8683	.001040583
962	925444	890277128	31.0161	9.8717	.001039501
963	927369	893056347	31.0322	9.8751	.001038422
964	929296	895841344	31.0483	9.8785	.001037344
965	931225	898632125	31.0644	9.8819	.001036269
966	933156	901428696	31.0805	9.8854	.001035197
967	935089	904231063	31.0966	9.8888	.001034126
968	937024	907039232	31.1127	9.8922	.001033058
969	938961	909853209	31.1288	9.8956	.001031992
970	940900	912673000	31.1448	9.8990	.001030928
971	942841	915498611	31.1609	9.9024	.001029866
972	944784	918330048	31.1769	9.9058	.001028807
973	946729	921167317	31.1929	9.9092	.001027749
974	948676	924010424	31.2090	9.9126	.001026694
975	950625	926859375	31.2250	9.9160	.001025641
976	952576	929714176	31.2410	9.9194	.001024590
977	954529	932574833	31.2570	9.9227	.001023541
978	956484	935441352	31.2730	9.9261	.001022495
979	958441	938313739	31.2890	9.9295	.001021450
980	960400	941192000	31.3050	9.9329	.001020408
981	962361	944076141	31.3209	9.9363	.001019368
982	964324	946966168	31.3369	9.9396	.001018330
983	966289	949862087	31.3528	9.9430	.001017294
984	968256	952763904	31.3688	9.9464	.001016260
985	970225	955671625	31.3847	9.9497	.001015228
986	972196	958585256	31.4006	9.9531	.001014199
987	974169	961504803	31.4166	9.9565	.001013171
988	976144	964430272	31.4325	9.9598	.001012146
989	978121	967361669	31.4484	9.9632	.001011122
990	980100	970299000	31.4643	9.9666	.001010101
991	982081	973242271	31.4802	9.9699	.001009082
992	984064	976191488	31.4960	9.9733	.001008065
993	986049	979146657	31.5119	9.9766	.001007049
994	988036	982107784	31.5278	9.9800	.001006036
995	990025	985074875	31.5436	9.9833	.001005025
996	992016	988047936	31.5595	9.9866	.001004016
997	994009	991026973	31.5753	9.9900	.001003009
998	996004	994011992	31.5911	9.9933	.001002004
999	998001	997002999	31.6070	9.9967	.001001001
1000	1000000	1000000000	31.6228	10	.001000000

CIRCUMFERENCES AND DIAMETERS OF CIRCLES.

DIAMETERS IN UNITS AND EIGHTHS.

Diam.	Circumf.	Area.	Diam.	Circumf.	Area.
1-64	.049087	.00019	1 7-16	4.51604	1.6230
1-32	.098175	.00077	½	4.71239	1.7671
3-64	.147262	.00173	9-16	4.90874	1.9175
1-16	.196350	.00307	⅝	5.10509	2.0739
3-32	.294524	.00690	11-16	5.30144	2.2365
⅛	.392699	.01227	¾	5.49779	2.4053
5-32	.490874	.01917	13-16	5.69414	2.5802
3-16	.589049	.02761	⅞	5.89049	2.7612
7-32	.687223	.03758	15-16	6.08684	2.9483
¼	.785398	.04909	2	6.28319	3.1416
9-32	.883573	.06213	1-16	6.47953	3.3410
5-16	.981748	.07670	⅛	6.67588	3.5466
11-32	1.07992	.09281	3-16	6.87223	3.7583
⅜	1.17810	.11045	¼	7.06858	3.9761
13-32	1.27627	.12962	5-16	7.26493	4.2000
7-16	1.37445	.15033	⅜	7.46128	4.4301
15-32	1.47262	.17257	7-16	7.65763	4.6664
½	1.57080	.19635	½	7.85398	4.9087
17-32	1.66897	.22166	9-16	8.05033	5.1572
9-16	1.76715	.24850	⅝	8.24668	5.4119
19-32	1.86532	.27688	11-16	8.44303	5.6727
⅝	1.96350	.30680	¾	8.63938	5.9396
21-32	2.06167	.33824	13-16	8.83573	6.2126
11-16	2.15984	.37122	⅞	9.03208	6.4918
23-32	2.25802	.40574	15-16	9.22843	6.7771
¾	2.35619	.44179	3	9.42478	7.0686
25-32	2.45437	.47937	1-16	9.62113	7.3662
13-16	2.55254	.51849	⅛	9.81748	7.6699
27-32	2.65072	.55914	3-16	10.0138	7.9798
⅞	2.74889	.60132	¼	10.2102	8.2958
29-32	2.84707	.64504	5-16	10.4065	8.6179
15-16	2.94524	.69029	⅜	10.6029	8.9462
31-32	3.04342	.73708	7-16	10.7992	9.2806
1	3.14159	.78540	½	10.9956	9.6211
1-16	3.33794	.88664	9-16	11.1919	9.9678
⅛	3.53429	.99402	⅝	11.3883	10.321
3-16	3.73064	1.1075	11-16	11.5846	10.680
¼	3.92699	1.2272	¾	11.7810	11.045
5-16	4.12334	1.3530	13-16	11.9773	11.416
⅜	4.31969	1.4849	⅞	12.1737	11.793

CIRCUMFERENCES AND DIAMETERS OF CIRCLES.—*Continued.*

Diam.	Circumf.	Area.	Diam.	Circumf.	Area.
3 15-16	12.3700	12.177	6⅞	21.5984	37.122
4	12.5664	12.566	7	21.9911	38.485
1-16	12.7627	12.962	⅛	22.3838	39.871
⅛	12.9591	13.364	¼	22.7765	41.282
3-16	13.1554	13.772	⅜	23.1692	42.718
¼	13.3518	14.186	½	23.5619	44.179
5-16	13.5481	14.607	⅝	23.9546	45.664
⅜	13.7445	15.033	¾	24.3473	47.173
7-16	13.9408	15.466	⅞	24.7400	48.707
½	14.1372	15.904	8	25.1327	50.265
9-16	14.3335	16.349	⅛	25.5254	51.849
⅝	14.5299	16.800	¼	25.9181	53.456
11-16	14.7262	17.257	⅜	26.3108	55.088
¾	14.9226	17.721	½	26.7035	56.745
13-16	15.1189	18.190	⅝	27.0962	58.426
⅞	15.3153	18.665	¾	27.4889	60.132
15-16	15.5116	19.147	⅞	27.8816	61.862
5	15.7080	19.635	9	28.2743	63.617
1-16	15.9043	20.129	⅛	28.6670	65.397
⅛	16.1007	20.629	¼	29.0597	67.201
3-16	16.2970	21.135	⅜	29.4524	69.029
¼	16.4934	21.648	½	29.8451	70.882
5-16	16.6897	22.166	⅝	30.2378	72.760
⅜	16.8861	22.691	¾	30.6305	74.662
7-16	17.0824	22.221	⅞	31.0232	76.589
½	17.2788	23.758	10	31.4159	78.540
9-16	17.4751	24.301	⅛	31.8086	80.516
⅝	17.6715	24.850	¼	32.2013	82.516
11-16	17.8678	25.406	⅜	32.5940	84.541
¾	18.0642	25.967	½	32.9867	86.590
13-16	18.2605	26.535	⅝	33.3794	88 664
⅞	18.4569	27.109	¾	33.7721	90.763
15-16	18.6532	27.688	⅞	34.1648	92.886
6	18.8496	28.274	11	34.5575	95.033
⅛	19.2423	29.465	⅛	34.9502	97.205
¼	19.6350	30.680	¼	35.3429	99.402
⅜	20.0277	31.919	⅜	35.7356	101.62
½	20.4204	33.183	½	36.1283	103.87
⅝	20.8131	34.472	⅝	36.5210	106.14
¾	21.2058	35.785	¾	36.9137	108.43

Diam.	Circumf.	Area.	Diam.	Circumf.	Area.
11⅞	37.3064	110.75	16 ⅞	53.0144	223.65
12	37.6991	113.10	17	53.4071	226.98
⅛	38.0918	115.47	⅛	53.7998	230.33
¼	38.4845	117.86	¼	54.1925	233.71
⅜	38.8772	120.28	⅜	54.5852	237.10
½	39.2699	122.72	½	54.9779	240.53
⅝	39.6626	125.19	⅝	55.3706	243.98
¾	40.0553	127.68	¾	55 7633	247.45
⅞	40.4480	130.19	⅞	56.1560	250.95
13	40.8407	132.73	18	56.5487	254.47
⅛	41.2334	135.30	⅛	56.9414	258.02
¼	41.6261	137.89	¼	57.3341	261.59
⅜	42.0188	140.50	⅜	57.7268	265.18
½	42.4115	143.14	½	58.1195	268.80
⅝	42.8042	145.80	⅝	58.5122	272.45
¾	43.1969	148.49	¾	58.9049	276.12
⅞	43 5896	151.20	⅞	59.2976	279.81
14	43.9823	153.94	19	59.6903	283.53
⅛	44.3750	156.70	⅛	60.0830	287.27
¼	44.7677	159.48	¼	60.4757	291.04
⅜	45.1604	162.30	⅜	60.8684	294.83
½	45.5531	165.13	½	61.2611	298.65
⅝	45.9458	167.99	⅝	61.6538	302.49
¾	46.3385	170.87	¾	62.0435	306.35
⅞	46.7312	173.78	⅞	62.4392	310.24
15	47.1239	176.71	20	62.8319	314.16
⅛	47.5166	179.67	⅛	63.2246	318.10
¼	47.9093	182.65	¼	63.6173	322.06
⅜	48.3020	185.66	⅜	64.0100	326.05
½	48.6947	188.69	½	64.4026	330.06
⅝	49.0874	191.75	⅝	64.7953	334.10
¾	49.4801	194.83	¾	65.1880	338.16
⅞	49.8728	197.93	⅞	65.5807	342.25
16	50.2655	201.06	21	65.9734	346.36
⅛	50.6582	204.22	⅛	66.3661	350.50
¼	51.0509	207.39	¼	66.7588	354.66
⅜	51.4436	210.60	⅜	67.1515	358.84
½	51.8363	213.82	½	67.5442	363.05
⅝	52.2290	217.08	⅝	67.9369	367.28
¾	52.6217	220.35	¾	68.3296	371.54

Diam.	Circumf.	Area.	Diam.	Circumf.	Area.
21⅞	68.7223	375.83	26⅞	84.4303	567.27
22	69.1150	380.13	27	84.8230	572.56
⅛	69.5077	384.46	⅛	85.2157	577.87
¼	69.9004	388.82	¼	85.6084	583.21
⅜	70.2931	393.20	⅜	86.0011	588.57
½	70.6858	397.61	½	86.3938	593.96
⅝	71.0785	402.04	⅝	86.7865	599.37
¾	71.4712	406.49	¾	87.1792	604.81
⅞	71.8639	410.97	⅞	87.5719	610.27
23	72.2566	415.48	28	87.9646	615.75
⅛	72.6493	420.00	⅛	88.3573	621.26
¼	73 0420	424.56	¼	88.7500	626.80
⅜	73.4347	429.13	⅜	89.1427	632.36
½	73.8274	433.74	½	89.5354	637.94
⅝	74.2201	438.36	⅝	89.9281	643.55
¾	74.6128	443.01	¾	90.3208	649.18
⅞	75.0055	447.69	⅞	90.7135	654.84
24	75.3982	452.39	29	91.1062	660.52
⅛	75.7909	457.11	⅛	91.4989	666.23
¼	76.1836	461.86	¼	91.8916	671.96
⅜	76.5763	466.64	⅜	92.2843	677.71
½	76.9690	471.44	½	92.6770	683.49
⅝	77.3617	476.26	⅝	93.0697	689.30
¾	77.7544	481.11	¾	93.4624	695.13
⅞	78.1471	485.98	⅞	93.8551	700.96
25	78.5398	490.87	30	94.2478	706.86
⅛	78.9325	495.79	⅛	94.6405	712.76
¼	79.3252	500.74	¼	95.0332	718.69
⅜	79.7179	505.71	⅜	95.4259	724.64
½	80.1106	510.71	½	95.8186	730.62
⅝	80.5033	515.72	⅝	96.2113	736.62
¾	80.8960	520.77	¾	96.6040	742.64
⅞	81.2887	525.84	⅞	96.9967	748.69
26	81.6814	530.93	31	97.3894	754.77
⅛	82.0741	536.05	⅛	97.7821	760.87
¼	82.4668	541.19	¼	98.1748	766.99
⅜	82.8595	546.35	⅜	98.5675	773.14
½	83.2522	551.55	½	98.9602	779.31
⅝	83.6449	556.76	⅝	99.3529	785.[illegible]
¾	84.0376	562.00	¾	99.7456	79[illegible]

Diam.	Circumf.	Area.	Diam.	Circumf.	Area.
31⅞	100.138	797.98	36⅞	115.846	1068.0
32	100.531	804.25	37	116.239	1075.2
⅛	100.924	810.54	⅛	116.632	1082.5
¼	101.316	816.86	¼	117.024	1089.8
⅜	101.709	823.21	⅜	117.417	1097.1
½	102.102	829.58	½	117.810	1104.5
⅝	102.494	835.97	⅝	118.202	1111.8
¾	102.887	842.39	¾	118.596	1119.2
⅞	103.280	848.83	⅞	118.988	1126.7
33	103.673	855.30	38	119.381	1134.1
⅛	104.065	861.79	⅛	119.773	1141.6
¼	104.458	868.31	¼	120.166	1149.1
⅜	104.851	874.85	⅜	120.559	1156.6
½	105.243	881.41	½	120.951	1164.2
⅝	105.636	888.00	⅝	121.344	1171.7
¾	106.029	894.62	¾	121.727	1179.3
⅞	106.421	901.26	⅞	122.129	1186.9
34	106.814	907.92	39	122.522	1194.6
⅛	107.207	914.61	⅛	122.915	1202.3
¼	107.600	921.32	¼	123.308	1210.0
⅜	107.992	928.06	⅜	123.700	1217.7
½	108.385	934.82	½	124.093	1225.4
⅝	108.778	941.61	⅝	124.486	1233.2
¾	109.170	948.42	¾	124.878	1241.0
⅞	109.563	955.25	⅞	125.271	1248.8
35	109.956	962.11	40	125.664	1256.6
⅛	110.348	969.00	⅛	126.056	1264.5
¼	110.741	975.91	¼	126.449	1272.4
⅜	111.134	982.84	⅜	126.842	1280.3
½	111.527	989.80	½	127.235	1288.2
⅝	111.919	996.78	⅝	127.627	1296.2
¾	112.312	1003.8	¾	128.020	1304.2
⅞	112.705	1010.8	⅞	128.413	1312.2
36	113.097	1017.9	41	128.805	1320.3
⅛	113.490	1025.0	⅛	129.198	1328.3
¼	113.883	1032.1	¼	129.591	1336.4
⅜	114.275	1039.2	⅜	129.983	1344.5
½	114.668	1046.3	½	130.376	1352.7
⅝	115.061	1053.5	⅝	130.769	1360.8
¾	115.454	1060.7	¾	131.161	1369.0

OF CIRCLES—*Continued.*

Diam.	Circumf.	Area.	Diam.	Circumf.	Area.
41⅞	131.554	1377.2	46⅞	147.262	1725.7
42	131.947	1385 4	47	147.655	1734.9
⅛	132.340	1393.7	⅛	148.048	1744.2
¼	132.732	1402.0	¼	148.440	1753.5
⅜	133.125	1410.3	⅜	148.833	1762.7
½	133.518	1418.6	½	149.226	1772.1
⅝	133.910	1427.0	⅝	149.618	1781.4
¾	134.303	1435.4	¾	150.011	1790.8
⅞	134.696	1443.8	⅞	150.404	1800.1
43	135.088	1452.2	48	150.796	1809.6
⅛	135.481	1460.7	⅛	151.189	1819.0
¼	135.874	1469.1	¼	151.582	1828.5
⅜	136.267	1477.6	⅜	151.975	1837.9
½	136.659	1486.2	½	152.367	1847.5
⅝	137.052	1494.7	⅝	152.760	1857.0
¾	137.445	1503.3	¾	153.153	1866.5
⅞	137.837	1511.9	⅞	153.545	1876.1
44	138.230	1520.5	49	153.938	1885.7
⅛	138.623	1529.2	⅛	154.331	1895.4
¼	139.015	1537.9	¼	154.723	1905.0
⅜	139.408	1546.6	⅜	155.116	1914.7
½	139.801	1555.3	½	155.509	1924.4
⅝	140.194	1564.0	⅝	155.902	1934.2
¾	140.586	1572.8	¾	156.294	1943.9
⅞	140.979	1581.6	⅞	156.687	1953.7
45	141.372	1590.4	50	157.080	1963.5
⅛	141.764	1599.3	⅛	157.472	1973.3
¼	142.157	1608.2	¼	157.865	1983.2
⅜	142.550	1617.0	⅜	158.258	1993.1
½	142.942	1626.0	½	158.650	2003.0
⅝	143.335	1634.9	⅝	159.043	2012.9
¾	143.728	1643.9	¾	159.436	2022.8
⅞	144.121	1652.9	⅞	159.829	2032.8
46	144.513	1661.9	51	160.221	2042.8
⅛	144.906	1670.9	⅛	160.614	2052.8
¼	145.299	1680.0	¼	161.007	2062.9
⅜	145.691	1689.1	⅜	161.399	2073.0
½	146.084	1698.2	½	161.792	2083.1
⅝	146.477	1707.4	⅝	162.185	2093.2
¾	146.869	1716.5	¾	162.577	2103.3

Diam.	Circumf.	Area.	Diam.	Circumf.	Area.
51⅞	162.970	2113.5	56⅞	178.678	2540.6
52	163.363	2123.7	57	179.071	2551.8
⅛	163.756	2133.9	⅛	179.463	2563.0
¼	164.148	2144.2	¼	179.856	2574.2
⅜	164.541	2154.5	⅜	180.249	2585.4
½	164.934	2164.8	½	180.642	2596.7
⅝	165.326	2175.1	⅝	181.034	2608.0
¾	165.719	2185.4	¾	181.427	2619.4
⅞	166.112	2195.8	⅞	181.820	2630.7
53	166.504	2206.2	58	182.212	2642.1
⅛	166.897	2216.6	⅛	182.605	2653.5
¼	167.290	2227.0	¼	182.998	2664.9
⅜	167.683	2237.5	⅜	183.390	2676.4
½	168.075	2248.0	½	183.783	2687.8
⅝	168.468	2258.5	⅝	184.176	2699.3
¾	168.861	2269.1	¾	184.569	2710 9
⅞	169.253	2279.6	⅞	184.961	2722.4
54	169.646	2290.2	59	185.354	2734.0
⅛	170.039	2300.8	⅛	195.747	2745.6
¼	170.431	2311.5	¼	186.139	2757.2
⅜	170.824	2322.1	⅜	186.532	2768.8
½	171.217	2332.8	½	186.925	2780.5
⅝	171.609	2343.5	⅝	187.317	2792.2
¾	172.002	2354.3	¾	187.710	2803.9
⅞	172.395	2365.0	⅞	188.103	2815.7
55	172.788	2375.8	60	188.496	2827.4
⅛	173.180	2386.6	⅛	188.888	2839.2
¼	173.573	2397.5	¼	189.281	2851.0
⅜	173.966	2408.3	⅜	189.674	2862.9
½	174.358	2419.2	½	190.066	2874.8
⅝	174.751	2430.1	⅝	190.459	2886.6
¾	175.144	2441.1	¾	190.852	2898.6
⅞	175.536	2452.0	⅞	191.244	2910.5
56	175.929	2463.0	61	191.637	2922.5
⅛	176.322	2474.0	⅛	192.030	2934.5
¼	176.715	2485.0	¼	192.423	2946.5
⅜	177.107	2496.1	⅜	192.815	2958.5
½	177.500	2507.2	½	193.208	2970.6
⅝	177.893	2518.3	⅝	193.601	2982.7
¾	178.285	2529.4	¾	193.993	2994.8

FOR DIAMETERS IN UNITS AND EIGHTHS—*Cont.*

Diam.	Circumf.	Area.	Diam.	Circumf.	Area.
61⅞	194.386	3006.9	**66⅞**	210.094	3512.5
62	194.779	3019.1	**67**	210.487	3525.7
⅛	195.171	3031.3	⅛	210.879	3538.8
¼	195.564	3043.5	¼	211.272	3552.0
⅜	195.957	3055.7	⅜	211.665	3565.2
½	196.350	3068.0	½	212.058	3578.5
⅝	196.742	3080.3	⅝	212.450	3591.7
¾	197.135	3092 6	¾	212.843	3605.0
⅞	197.528	3104.9	⅞	213.236	3618.3
63	197.920	3117.2	**68**	213.628	3631.7
⅛	198.313	3129.6	⅛	214.021	3645.0
¼	198.706	3142.0	¼	214.414	3658.4
⅜	199.098	3154.5	⅜	214.806	3671.8
½	199.491	3166.9	½	215.199	3685.3
⅝	199.884	3179.4	⅝	215.592	3698.7
¾	200.277	3191.9	¾	215.984	3712.2
⅞	200.669	3204.4	⅞	216.377	3725.7
64	201.062	3217.6	**69**	216.770	3739.3
⅛	201.455	3229.6	⅛	217.163	3752.8
¼	201.847	3242.2	¼	217.555	3766.4
⅜	202.240	3254.8	⅜	217.948	3780.0
½	202.633	3267.5	½	218.341	3793.7
⅝	203.025	3280.1	⅝	218.733	3807.3
¾	203.418	3292.8	¾	219.126	3821.0
⅞	203.811	3305.6	⅞	219.519	3834.7
65	204.204	3318.3	**70**	219.911	3848.5
⅛	204.596	3331.1	⅛	220.304	3862.2
¼	204.989	3343.9	¼	220.697	3876.0
⅜	205.382	3356.7	⅜	221.090	3889.8
½	205.774	3369.6	½	221.482	3903.6
⅝	206.167	3382.4	⅝	221.875	3917.5
¾	206.560	3395.3	¾	222.268	3931.4
⅞	206.952	3408.2	⅞	222.660	3945.3
66	207.345	3421.2	**71**	223.053	3959.2
⅛	207.738	3434.2	⅛	223.446	3973.1
¼	208.131	3447.2	¼	223.838	3987.1
⅜	208.523	3460.2	⅜	224.231	4001.1
½	208.916	3473.2	½	224.624	4015.2
⅝	209.309	3486.3	⅝	225.017	4029.2
¾	209.701	3499.4	¾	225 409	404[illegible]

CIRCUMFERENCES AND AREAS OF CIRCLES

Diam.	Circumf.	Area.	Diam.	Circumf.	Area.
71⅞	225.802	4057.4	76⅞	241.510	4641.5
72	226.195	4071.5	77	241.903	4656.6
⅛	226 587	4085.7	⅛	242.295	4671.8
¼	226.980	4099.8	¼	242.688	4686.9
⅜	227.373	4114.0	⅜	243.081	4702 1
½	227.765	4128.2	½	243.473	4717.3
⅝	228.158	4142.5	⅝	243.866	4732.5
¾	228.551	4156.8	¾	244.259	4747.8
⅞	228.944	4171.1	⅞	244.652	4763 1
73	229.336	4185.4	78	245.044	4778.4
⅛	229.729	4199.7	⅛	245.437	4793.7
¼	230.122	4214.1	¼	245.830	4809.0
⅜	230.514	4228.5	⅜	246.222	4824.4
½	230.907	4242.9	½	246.615	4839.8
⅝	231.300	4257.4	⅝	247.008	4855.2
¾	231.692	4271.8	¾	247.400	4870.7
⅞	232.085	4286.3	⅞	247.793	4886.2
74	232.478	4300.8	79	248.186	4901.7
⅛	232.871	4315.4	⅛	248.579	4917.2
¼	233 263	4329.9	¼	248.971	4932.7
⅜	233.656	4344.5	⅜	249.364	4948.3
½	234.049	4359.2	½	249.757	4963.9
⅝	234 441	4373.8	⅝	250.149	4979.5
¾	234.834	4388.5	¾	250.542	4995.2
⅞	235.227	4403.1	⅞	250.935	5010.9
75	235.619	4417.9	80	251.327	5026.5
⅛	236.012	4432.6	⅛	251.720	5042.3
¼	236.405	4447.4	¼	252.113	5058.0
⅜	236.798	4462.2	⅜	252.506	5073.8
½	237.190	4477.0	½	252.898	5089.6
⅝	237.583	4491.8	⅝	253.291	5105.4
¾	237.976	4506.7	¾	253.684	5121.2
⅞	238.368	4521.5	⅞	254.076	5137.1
76	238.761	4536.5	81	254.469	5153.0
⅛	239.154	4551.4	⅛	254.862	5168.9
¼	239.546	4566.4	¼	255.254	5184 9
⅜	239.939	4581.3	⅜	255.647	5200.8
½	240.332	4596.3	½	256.040	5216.8
⅝	240.725	4611.4	⅝	256.433	5232.8
¾	241.117	4626.4	¾	256.825	5248.9

FOR DIAMETERS IN UNITS AND EIGHTHS—*Cont.*

Diam.	Circumf.	Area.	Diam.	Circumf.	Area.
81⅞	257.218	5264.9	86⅞	272.926	5927.6
82	257.611	5281.0	87	273.319	5944.7
⅛	258.003	5297.1	⅛	273 711	5961.8
¼	258.396	5313.3	¼	274.104	5978.9
⅜	258.789	5329.4	⅜	274.497	5996.0
½	259.181	5345.6	½	274.889	6013.2
⅝	259.574	5361.8	⅝	275.282	6030.4
¾	259.967	5378.1	¾	275.675	6047.6
⅞	260.359	5394.3	⅞	276.067	6064.9
83	260.752	5410.6	88	276.460	6082.1
⅛	261.145	5426.9	⅛	276.853	6099.4
¼	261.538	5443.3	¼	277 246	6116.7
⅜	261.930	5459.6	⅜	277.638	6134.1
½	262.323	5476.0	½	278.031	6151.4
⅝	262.716	5492.4	⅝	278.424	6168.8
¾	263.108	5508.8	¾	278.816	6186.2
⅞	263.501	5525.3	⅞	279.209	6203.7
84	263.894	5541.8	89	279.602	6221.1
⅛	264.286	5558.3	⅛	279.994	6238.6
¼	264.679	5574.8	¼	280.387	6256.1
⅜	265.072	5591.4	⅜	280.780	6273.7
½	265.465	5607.9	½	281.173	6291.2
⅝	265.857	5624.5	⅝	281.565	6308.8
¾	266.250	5641.2	¾	281 958	6326.4
⅞	266.643	5657.8	⅞	282.351	6344.1
85	267.035	5674.5	90	282.743	6361.7
⅛	267.428	5691.2	⅛	283.136	6379.4
¼	267.821	5707.9	¼	283.529	6397.1
⅜	268.213	5724.7	⅜	283.921	6414.9
½	268.606	5741.5	½	284.314	6432.6
⅝	268.999	5758.3	⅝	284.707	6450.4
¾	269.392	5775.1	¾	285.100	6468.2
⅞	269.784	5791.9	⅞	285.492	6486.0
86	270.177	5808.8	91	285.885	6503.9
⅛	270.570	5825.7	⅛	286.278	6521.8
¼	270.962	5842.6	¼	286.670	6539.7
⅜	271.355	5859.6	⅜	287.063	6557.6
½	271.748	5876.5	½	287 456	6575.5
⅝	272.140	5893.5	⅝	287.848	6593.5
¾	272.533	5910.6	¾	288.241	661

CIRCUMFERENCES AND AREAS OF CIRCLES FOR DIAMETERS IN UNITS AND EIGHTHS—*Cont.*

Diam.	Circumf.	Area.	Diam.	Circumf.	Area.
91⅞	288 634	6629.6	96¼	302.378	7276.0
92	289.027	6647.6	⅜	302.771	7294.9
⅛	289.419	6665.7	½	303.164	7313.8
¼	289.812	6683.8	⅝	303.556	7332.8
⅜	290.205	6701.9	¾	303.949	7351.8
½	290.597	6720.1	⅞	304.342	7370.8
⅝	290 990	6738.2	97	304.734	7389.8
¾	291.383	6756.4	⅛	305.127	7408.9
⅞	291.775	6774.7	¼	305.520	7428.0
93	292.168	6792.9	⅜	305.913	7447.1
⅛	292.561	6811.2	½	306.305	7466.2
¼	292.954	6829.5	⅝	306.698	7485.3
⅜	293.346	6847.8	¾	307.091	7504.5
½	293.739	6866.1	⅞	307.483	7523.7
⅝	294.132	6884.5	98	307.876	7543.0
¾	294.524	6902.9	⅛	308.269	7562.2
⅞	294.917	6921.3	¼	308.661	7581.5
94	295.310	6939.8	⅜	309.054	7600.8
⅛	295.702	6958.2	½	309.447	7620.1
¼	296.095	6976.7	⅝	309.840	7639.5
⅜	296.488	6995.3	¾	310.232	7658.9
½	296.881	7013.8	⅞	310.625	7678.3
⅝	297.273	7032.4	99	311.018	7697.7
¾	297.666	7051.0	⅛	311.410	7717.1
⅞	298.059	7069.6	¼	311.803	7736.6
95	298.451	7088.2	⅜	312.196	7756.1
⅛	298.844	7106.9	½	312.588	7775.6
¼	299.237	7125.6	⅝	312.981	7795.2
⅜	299.629	7144.3	¾	313.374	7814.8
½	300.022	7163.0	⅞	313.767	7834.4
⅝	300.415	7181.8	100	314.159	7854.0
¾	300.807	7200.6			
⅞	301.200	7219.4			
96	301.593	7238.2			
⅛	301.986	7257.1			

CIRCUMFERENCES AND AREAS OF CIRCLES FOR DIAMETERS IN FEET AND INCHES.

Diam.		Circumf.	Area.	Diam.		Circumf.	Area.
Ft.	In.	Feet.	Sq. Ft.	Ft.	In.	Feet.	Sq. Ft.
	1	.261799	.005454	3	5	10.73377	9.16843
	2	.523599	.021817		6	10.99557	9.62113
	3	.785398	.049087		7	11.25737	10.08473
	4	1.047198	.087266		8	11.51917	10.55924
	5	1.308997	.136354		9	11.78097	11.04466
	6	1.570796	.196350		10	12.04277	11.54099
	7	1.832596	.267254		11	12.30457	12.04823
	8	2.094395	.349066	4	0	12.56637	12.56637
	9	2.356195	.441786		1	12.82817	13.09542
	10	2.617994	.545415		2	13.08997	13.63538
	11	2.879793	.659953		3	13.35177	14.18625
1	0	3.14159	.785398		4	13.61357	14.74803
	1	3.40339	.921752		5	13.87537	15.32072
	2	3.66519	1.06901		6	14.13717	15.90431
	3	3.92699	1.22718		7	14.39897	16.49882
	4	4.18879	1.39626		8	14.66077	17.10423
	5	4.45059	1.57625		9	14.92257	17.72055
	6	4.71239	1.76715		10	15.18436	18.34777
	7	4.97419	1.96895		11	15.44616	18.98591
	8	5.23599	2.18166	5	0	15.70796	19.63495
	9	5.49779	2.40528		1	15.96976	20.29491
	10	5.75959	2.63981		2	16.23156	20.96577
	11	6.02139	2.88525		3	16.49336	21.64754
2	0	6.28319	3.14159		4	16.75516	22.34021
	1	6.54498	3.40885		5	17.01696	23.04380
	2	6.80678	3.68701		6	17.27876	23.75829
	3	7.06858	3.97608		7	17.54056	24.48370
	4	7.33038	4.27606		8	17.80236	25.22001
	5	7.59218	4.58694		9	18.06416	25.96723
	6	7.85398	4.90874		10	18.32596	26.72535
	7	8.11578	5.24144		11	18.58776	27.49439
	8	8.37758	5.58505	6	0	18.84956	28.27433
	9	8.63938	5.93957		1	19.11136	29.06519
	10	8.90118	6.30500		2	19.37315	29.86695
	11	9.16298	6.68134		3	19.63495	30.67962
3	0	9.42478	7.06858		4	19.89675	31.50319
	1	9.68658	7.46674		5	20.15855	32 33768
	2	9.94838	7.87580		6	20.42035	33.18307
	3	10.21018	8.29577		7	20.68215	34 03937
	4	10.47198	8.72665		8	20.94395	34.90659

CIRCUMFERENCES AND AREAS OF CIRCLES

Diam. Ft.	Diam. In.	Circumf. Feet.	Area. Sq. Ft.	Diam. Ft.	Diam. In.	Circumf. Feet.	Area. Sq. Ft.
6	9	21.20575	35.78470	10	1	31.67773	79 85427
	10	21.46755	36 67373		2	31.93953	81.17963
	11	21.72935	37.57367		3	32.20132	82.51589
7	0	21.99115	38.48451		4	32.46312	83.86307
	1	22.25295	39.40626		5	32.72492	85.22115
	2	22.51475	40.33892		6	32.98672	86.59015
	3	22.77655	41 28249		7	33.24852	87.97005
	4	23.03835	42.23697		8	33.51032	89.36086
	5	23.30015	43.20235		9	33.77212	90 76258
	6	23.56194	44.17865		10	34.03392	92.17520
	7	23.82374	45.16585		11	34.29572	93.59674
	8	24.06554	46.16396	11	0	34.55752	95.03318
	9	24.34734	47.17298		1	34.81932	96.47853
	10	24.60914	48.19290		2	35.08112	97.93479
	11	24.87094	49.22374		3	35.34292	99.40196
8	0	24.13274	50.26548		4	35.60472	100.8800
	1	25.39454	51.31813		5	35.86652	102.3690
	2	25.65634	52.38169		6	36.12832	103.8689
	3	25 91814	53.45616		7	36.39011	105.3797
	4	26.17994	54.54154		8	36.65191	106.9014
	5	26.44174	55 63782		9	36.91371	108.4340
	6	26.70354	56.74502		10	37.17551	109.9776
	7	26.96534	57.86312		11	37.43731	111.5320
	8	27.22714	58.99213	12	0	37.69911	113.0973
	9	27.48894	60.13205		1	37.96091	114.6736
	10	27.75074	61.28287		2	38.22271	116.2607
	11	28.01253	62.44461		3	38.48451	117.8588
9	0	28.27433	63.61725		4	38.74631	119.4678
	1	28.53613	64.80080		5	39.00811	121.0877
	2	28.79793	65.99526		6	39.26991	122.7185
	3	29.05973	67.20063		7	39.53171	124.3602
	4	29.32153	68.41691		8	39.79351	126.0128
	5	29.58333	69.64409		9	40.05531	127.6763
	6	29.84513	70.88218		10	40.31711	129.3507
	7	30.10693	72.13119		11	40.57891	131.0360
	8	30.36873	73.39110	13	0	40.84070	132.7323
	9	30.63053	74.66191		1	41.10250	134.4394
	10	30.89233	75.94364		2	41.36430	136.1575
	11	31.15413	77.23627		3	41.62610	137.8865
10	0	31.41593	78.53928		4	41.88790	139.6263

FOR DIAMETERS IN FEET AND INCHES—*Cont.*

Diam. Ft.	Diam. In.	Circumf. Feet.	Area. Sq. Ft.	Diam. Ft.	Diam. In.	Circumf. Feet.	Area. Sq. Ft.
13	5	42.14970	141.3771	**16**	9	52.62168	220.3533
	6	42.41150	143.1388		10	52.88348	222.5513
	7	42.67330	144.9114		11	53.14528	224.7602
	8	42.93510	146.6949	**17**	0	53.40708	226.9801
	9	43.19690	148.4893		1	53.66887	229.2108
	10	43.45870	150.2957		2	53.93067	231.4525
	11	43.72050	152.1109		3	54.19247	233.7050
14	0	43.98230	153.9380		4	54.45427	235.9685
	1	44.24410	155.7761		5	54.71607	238.2429
	2	44.50590	157.6250		6	54.97787	240.5282
	3	44.76770	159.4849		7	55.23967	242.8244
	4	45.02949	161.3557		8	55.50147	245.1315
	5	45.29129	163.2374		9	55.76327	247.4495
	6	45.55309	165.1300		10	56.02507	249.7784
	7	45.81489	167.0335		11	56.28687	252.1183
	8	46.07669	168.9479	**18**	0	56.54867	254.4690
	9	46.33849	170.8732		1	56.81047	256.8307
	10	46.60029	172.8094		2	57.07227	259.2032
	11	46.86209	174.7565		3	57.33407	261.5867
15	0	47.12389	176.7146		4	57.59587	263.9810
	1	47.38569	178.6835		5	57.85766	266.3863
	2	47.64749	180.6634		6	58.11946	268.8025
	3	47.90929	182.6542		7	58.38126	271.2296
	4	48.17109	184.6558		8	58.64306	273.6676
	5	48.43289	186.6684		9	58.90486	276.1165
	6	48.69469	188.6919		10	59.16666	278.5764
	7	48.95649	190.7263		11	59.42846	281.0471
	8	49.21828	192.7716	**19**	0	59.69026	283.5287
	9	49.48008	194.8278		1	59.95206	286.0213
	10	49.74188	196.8950		2	60.21386	288.5247
	11	50.00368	198.9730		3	60.47566	291.0391
16	0	50.26548	201.0619		4	60.73746	293.5644
	1	50.52728	203.1618		5	60.99926	296.1006
	2	50.78908	205.2725		6	61.26106	298.6477
	3	51.05088	207.3942		7	61.52286	301.2056
	4	51.31268	209.5268		8	61.78466	303.7746
	5	51.57448	211.6703		9	62.04645	306.3544
	6	51.83628	213.8246		10	62.30825	308.9451
	7	52.09808	215.9899		11	62.57005	311.5467
	8	52.35988	218.1662	**20**	0	62.83185	314.1592

CIRCUMFERENCES AND AREAS OF CIRCLES

Diam.		Circumf.	Area.	Diam.		Circumf.	Area.
Ft.	In.	Feet.	Sq. Ft.	Ft.	In.	Feet.	Sq. Ft.
20	1	63.09365	316.7827	23	5	73.56563	430.6654
	2	63.35545	319.4171		6	73.82743	433.7361
	3	63.61725	322.0623		7	74.08923	436.8177
	4	63.87905	324.7185		8	74.35103	439.9102
	5	64.14085	327.3856		9	74.61283	443.0137
	6	64.40265	330.0636		10	74.87462	446.1280
	7	64.66445	332.7525		11	75.13642	449.2532
	8	64.92625	335.4523	24	0	75.39822	452.3893
	9	65.18805	338.1630		1	75.66002	455.5364
	10	65.44985	340.8846		2	75.92182	458.6943
	11	65.71165	343.6172		3	76.18362	461.8632
21	0	65.97345	346.3606		4	76.44542	465.0430
	1	66.23525	349.1149		5	76.70722	468.2337
	2	66.49704	351.8802		6	76.96902	471.4352
	3	66.75884	354.6564		7	77.23082	474.6477
	4	67.02064	357.4434		8	77.49262	477.8711
	5	67.28244	360.2414		9	77.75442	481.1055
	6	67.54424	363.0503		10	78.01622	484.3507
	7	67.80604	365.8701		11	78.27802	487.6068
	8	68.06784	368.7008	25	0	78.53982	490.8739
	9	68.32964	371.5424		1	78.80162	494.1518
	10	68.59144	374.3949		2	79.06342	497.4407
	11	68.85324	377.2584		3	79.32521	500.7404
22	0	69.11504	380.1327		4	79.58701	504.0511
	1	69.37684	383.0180		5	79.84881	507.3727
	2	69.63864	385.9141		6	80.11061	510.7052
	3	69.90044	388.8212		7	80.37241	514.0486
	4	70.16224	391.7392		8	80.63421	517.4029
	5	70.42404	394.6680		9	80.89601	520.7681
	6	70.68583	397.6078		10	81.15781	524.1442
	7	70 94763	400.5585		11	81.41961	527.5312
	8	71.20943	403.5201	26	0	81.68141	530.9292
	9	71.47123	406.4926		1	81.94321	534.3380
	10	71.73303	409.4761		2	82.20501	537.7578
	11	71.99483	412.4704		3	82.46681	541.1884
23	0	72.25663	415.4756		4	82.72861	544.6300
	1	72.51843	418.4918		5	82.99041	548.0825
	2	72.78023	421.5188		6	83.25221	551.5459
	3	73.04203	424.5568		7	83.51400	555.0202
	4	73.30383	427.6057		8	83.77580	558.5054

FOR DIAMETERS IN FEET AND INCHES—*Cont.*

Diam. Ft.	Diam. In.	Circumf. Feet.	Area. Sq. Ft.	Diam. Ft.	Diam. In.	Circumf. Feet.	Area. Sq. Ft.
26	9	84.03760	562.0015	28	5	89.27359	634.2145
	10	84.29940	565.5085		6	89.53539	637.9397
	11	84.56120	569.0264		7	89.79719	641.6758
27	0	84.82300	572.5553		8	90.05899	645.4228
	1	85.08480	576.0950		9	90.32079	649.1807
	2	85.34660	579.6457		10	90.58259	652.9495
	3	85.60840	583.2072		11	90.84439	656.7292
	4	85.87020	586.7792	29	0	91.10619	660.5199
	5	86.13200	590.3631		1	91.36799	664.3214
	6	86.39380	593.9574		2	91.62979	668.1339
	7	86.65560	597.5626		3	91.89159	671.9572
	8	86.91740	601.1787		4	92.15339	675.7915
	9	87.17920	604.8057		5	92.41518	679.6367
	10	87.44100	608.4436		6	92.67698	683.4928
	11	87.70279	612.0924		7	92.93878	687.3597
28	0	87.96459	615.7522		8	93.20058	691.2377
	1	88.22639	619.4228		9	93.46238	695.1265
	2	88.48819	623.1044		10	93.72418	699.0262
	3	88.74999	626.7968		11	93.98598	702.9368
	4	89.01179	630.5002	30	0	94.24778	706.8583

FEET EXPRESSED IN DECIMALS OF A MILE.

Feet.	Decimal of Mile.	Feet.	Decimal of Mile.
1	.000189	6	.001136
2	.000378	7	.001325
3	.000568	8	.001514
4	.000757	9	.001704
5	.000946		

DECIMALS OF AN INCH FOR EACH 1-64.

Fractions.	Decimals.	Fractions.	Decimals.
1-64	.015625	33-64	.515625
1-32	.03125	17-32	.53125
3-64	.046875	35-64	.546875
1-16	.0625	9-16	.5625
5-64	.078125	37-64	.578125
3-32	.09375	19-32	.59375
7-64	.109375	39-64	.609375
1-8	.125	5-8	.625
9-64	.140625	41-64	.640625
5-32	.15625	21-32	.65625
11-64	.171875	43-64	.671875
3-16	.1875	11-16	.6875
13-64	.203125	45-64	.703125
7-32	.21875	23-32	.71875
15-64	.234375	47-64	.734375
1-4	.25	3-4	.75
17-64	.265625	49-64	.765625
9-32	.28125	25-32	.78125
19-64	.296875	51-64	.796875
5-16	.3125	13-16	.8125
21-64	.328125	53-64	.828125
11-32	.34375	27-32	.84375
23-64	.359375	55-64	.859375
3-8	.375	7-8	.875
25-64	.390625	57-64	.890625
13-32	.40625	29-32	.90625
27-64	.421875	59-64	.921875
7-16	.4375	15-16	.9375
29-64	.453125	61-64	.953125
15-32	.46875	31-32	.96875
31-64	.484375	63-64	.984375
1-2	.5	1	1.0

INCHES EXPRESSED IN DECIMALS OF A FOOT.

Inches.	Feet.	Inches.	Feet.	Inches.	Feet.
0 1-64	.0013	1 ¼	.1042	2 ½	.2083
1-32	.0026	9-32	.1068	17-32	.2109
1-16	.0052	5-16	.1094	9-16	.2135
3-32	.0078	11-32	.1120	19-32	.2161
⅛	.0104	⅜	.1146	⅝	.2188
5-32	.0130	13-32	.1172	21-32	.2214
3-16	.0156	7-16	.1198	11-16	.2240
7-32	.0182	15-32	.1224	23-32	.2266
¼	.0208	½	.1250	¾	.2292
9-32	.0234	17-32	.1276	25-32	.2318
5-16	.0260	9-16	.1302	13-16	.2344
11-32	.0286	19-32	.1328	27-32	.2370
⅜	.0312	⅝	.1354	⅞	.2396
13-32	.0339	21-32	.1380	29-32	.2422
7-16	.0365	11-16	.1406	15-16	.2448
15-32	.0391	23-32	.1432	31-32	.2474
½	.0417	¾	.1458	3	.2500
17-32	.0443	25-32	.1484	1-32	.2526
9-16	.0469	13-16	.1510	1-16	.2552
19-32	.0495	27-32	.1536	3-32	.2578
⅝	.0521	⅞	.1562	⅛	.2604
21-32	.0547	29-32	.1589	5-32	.2630
11-16	.0573	15-16	.1615	3-16	.2656
23-32	.0599	31-32	.1641	7-32	.2682
¾	.0625	2	.1667	¼	.2708
25-32	.0651	1-32	.1693	9-32	.2734
13-16	.0677	1-16	.1719	5-16	.2760
27-32	.0703	3-32	.1745	11-32	.2786
⅞	.0729	⅛	1771	⅜	.2812
29-32	.0755	5-32	.1797	13-32	.2839
15-16	.0781	3-16	.1823	7-16	.2865
31-32	.0807	7-32	.1849	15-32	.2891
1	.0833	¼	.1875	½	.2917
1-32	.0859	9-32	.1901	17-32	.2943
1-16	.0885	5-16	.1927	9-16	.2969
3-32	.0911	11-32	.1953	19-32	.2995
⅛	.0937	⅜	.1979	⅝	.3021
5-32	.0964	13-32	.2005	21-32	.3047
3-16	.0990	7-16	.2031	11-16	.3073
7-32	.1016	15-32	.2057	23-32	.3099

INCHES EXPRESSED IN DECIMALS OF A FOOT—*Continued.*

Inches.	Feet.	Inches.	Feet.	Inches.	Feet.
3 ¾	.3125	5	.4167	6 ¼	.5208
25-32	.3151	1-32	.4193	9-32	.5234
13-16	.3177	1-16	.4219	5-16	.5260
27-32	.3203	3-32	.4245	11-32	.5286
⅞	.3229	⅛	.4271	⅜	.5312
29-32	.3255	5-32	.4297	13-32	.5339
15-16	.3281	3-16	.4323	7-16	.5365
31-32	.3307	7-32	.4349	15-32	.5391
4	.3333	¼	.4375	½	.5417
1-32	.3359	9-32	.4401	17-32	.5443
1-16	.3385	5-16	.4427	9-16	.5469
3-32	.3411	11-32	4453	19-32	.5495
⅛	.3437	⅜	.4479	⅝	.5521
5-32	.3464	13-32	.4505	21-32	.5547
3-16	.3490	7-16	.4531	11-16	.5573
7-32	.3516	15-32	.4557	23-32	.5599
¼	.3542	½	.4583	¾	.5625
9-32	.3568	17-32	.4609	25-32	.5651
5-16	.3594	9-16	.4635	13-16	.5677
11-32	.3620	19-32	.4661	27-32	.5703
⅜	.3646	⅝	.4688	⅞	.5729
13-32	.3672	21-32	.4714	29-32	.5755
7-16	.3698	11-16	.4740	15-16	.5781
15-32	.3724	23-32	.4766	31-32	.5807
½	.3750	¾	.4792	7	.5833
17-32	.3776	25-32	.4818	1-32	.5859
9-16	.3802	13-16	.4844	1-16	.5885
19-32	.3828	27-32	.4870	3-32	.5911
⅝	.3854	⅞	.4896	⅛	.5937
21-32	.3880	29-32	.4922	5-32	.5964
11-16	.3906	15-16	.4948	3-16	.5990
23-32	.3932	31-32	.4974	7-32	.6016
¾	.3958	6	.5000	¼	.6042
25-32	.3984	1-32	.5026	9-32	.6068
13-16	.4010	1-16	5052	5-16	.6094
27-32	.4036	3-32	.5078	11-32	.6120
⅞	.4062	⅛	.5104	⅜	.6146
29-32	.4089	5-32	.5130	13-32	.6172
15-16	.4115	3-16	.5156	7-16	.6198
31-32	.4141	7-32	.5182	15-32	.6224

INCHES EXPRESSED IN DECIMALS OF A FOOT—*Continued.*

Inches.	Feet.	Inches.	Feet.	Inches.	Feet.
7 ½	.6250	8 ¾	.7292	10	.8333
17-32	.6276	25-32	.7318	1-32	.8359
9-16	.6302	13-16	.7344	1-16	.8385
19-32	.6328	27-32	.7370	3-32	.8411
⅝	.6354	⅞	.7396	⅛	.8437
21-32	.6380	29-32	.7422	5-32	.8464
11-16	.6406	15-16	.7448	3-16	.8490
23-32	.6432	31-32	.7474	7-32	.8516
¾	.6458	9	.7500	¼	.8542
25-32	.6484	1-32	.7526	9-32	.8568
13-16	.6510	1-16	.7552	5-16	.8594
27-32	.6536	3-32	.7578	11-32	.8620
⅞	.6562	⅛	.7604	⅜	.8646
29-32	.6589	5-32	.7630	13-32	.8672
15-16	.6615	3-16	.7656	7-16	.8698
31-32	.6641	7-32	.7682	15-32	.8724
8	.6667	¼	.7708	½	.8750
1-32	.6693	9-32	.7734	17-32	.8776
1-16	.6719	5-16	.7760	9-16	.8802
3-32	.6745	11-32	.7786	19-32	.8828
⅛	.6771	⅜	.7812	⅝	.8854
5-32	.6797	13-32	.7839	21-32	.8880
3-16	.6823	7-16	.7865	11-16	.8906
7-32	.6849	15-32	.7891	23-32	.8932
¼	.6875	½	.7917	¾	.8958
9-32	.6901	17-32	.7943	25-32	.8984
5-16	.6927	9-16	.7969	13-16	.9010
11-32	.6953	19-32	.7995	27-32	.9036
⅜	.6979	⅝	.8021	⅞	.9062
13-32	.7005	21-32	.8047	29-32	.9089
7-16	.7031	11-16	.8073	15-16	.9115
15-32	.7057	23-32	.8099	31-32	.9141
½	.7083	¾	.8125	11	.9167
17-32	.7109	25-32	.8151	1-32	.9193
9-16	.7135	13-16	.8177	1-16	.9219
19-32	.7161	27-32	.8203	3-32	.9245
⅝	.7188	⅞	.8229	⅛	.9271
21-32	.7214	29-32	.8255	5-32	.9297
11-16	.7240	15-16	.8281	3-16	.9323
23-32	.7266	31-32	.8307	7-32	.9349

INCHES EXPRESSED IN DECIMALS OF A FOOT—*Continued.*

Inches.	Feet.	Inches.	Feet.	Inches.	Feet.
11 ¼	.9375	11 ½	.9583	11 ¾	.9792
9-32	.9401	17-32	.9609	25-32	.9818
5-16	.9427	9-16	.9635	13-16	.9844
11-32	.9453	19-32	.9661	27-32	.9870
⅜	.9479	⅝	.9688	⅞	.9896
13-32	.9505	21-32	.9714	29-32	.9922
7-16	.9531	11-16	.9740	15-16	.9948
15-32	.9557	23-32	.9766	31-32	.9974
				12	1.0000

MEASURE OF SURFACE.

Square Miles.	Acres.	Square Chains.	Square Rods.	Square Yards.	Square Feet.
1	640	6400	102400		
	1	10	160	4840	43560
		1	16	484	4356
			1	30.25	272.25
				1	9

Acres per foot of width and per 1000′ run = .02295.
" " " " " " " mile run = .12117.

MEASURES OF LENGTH.

Miles.	Furlongs.	Chains.	Rods.	Yards.	Feet.	Inches.
1	8	80	320	1760	5280	63360
	1	10	40	220	660	7920
		1	4	22	66	792
			1	5.5	16.5	198
				1	3	36
					1	12

EQUIVALENT VALUES IN ENGLISH AND METRIC SYSTEMS.

1 inch = .025399 metres.
1 foot = .3047964 “
1 yard = .9143892 “
1 mile = 1609.3 “
1 metre = 39.37043 inches.
1 “ = 3.28086 feet.
1 “ = 1.09362 yards.

1 square inch = 6.4516 square cm.
1 “ foot = 928.989 “ “
1 “ yard = 8361 “ “
1 “ cm. = .155 “ inches.
1 “ “ = .001076 “ feet.
1 “ “ = .00011961 “ yards.

1 cubic inch = 16.386 cubic cm.
1 “ foot = 28315.33 “ “
1 “ yard = .764505 “ m.
1 gallon = 3.78521 litres (= 231 cu. in.).
1 cubic c.m. = .06102 cubic inches.
1 “ “ = .0000353 “ feet.
1 “ m. = 35.3169 “ “
1 “ “ = 1.308 “ yards.
1 litre = 61.027 “ inches.
1 “ = .264189 gallons.
1 pound (Avd.) = .453603 kg.
1 long ton = 1016.07 kg.
1 short “ = 907.206 kg.
1 kilogram = 2.2046 pounds.
1 “ = .000984 long tons.
1 “ = .001102 short “

BOARD MEASURE.

Number of feet board measure = .08333 × length in feet × width in inches × thickness in inches.

MEASURES OF PRESSURE.

	Atmospheres.	Lbs. per Sq. In.	Inches Mercury.	Feet of Water 60° F.	Mm. of Mercury.	Lbs. per Sq. Ft.	Kg. per Sq. M.
Atmospheres..................	1	14.7	29.922	33.93	760	2116	10333
Pounds per square inch........	.06803	1	2.036	2.309	51.7	143.95	702.92
Inches of mercury.............	.03342	.4913	1	1.134	25.398	70.7	345.33
Feet of water 60° F...........	.02947	.4332	.8818	1	22.399	62.363	304.56
Mm. of mercury................		.01934	.03937	.04464	1	2.784	13.596
Pounds per square foot........			.01414	.01603	.3592	1	4.883
Kg. per square metre..........			.002895	.003283	.07355	.2048	1

PERCH.

A perch of masonry is 16½′ × 1½′ × 1′, and therefore contains 24¾ cu. ft. Usually taken as 25 cu. ft.

For Perch of 24¾ Cu. Ft.	For Perch of 25 Cu. Ft.
1 perch = .9166 cu. yds.	1 perch = .9259 cu. yds.
1 cu. yd. = 1 09091 perches.	1 cu. yd. = 1.08 perches.

CAPACITY OF CYLINDERS.

PER FOOT IN DIAMETER AND HEIGHT.

1357.1712 cu. inches.
.7854 cu. ft.
.02909 cu. yds.
5.8752 liquid gals.
22.2395 litres.

PER INCH IN DIAMETER AND FOOT OF HEIGHT.

9.4248 cu. inches.
.005454 cu. ft.
.0408 liquid gals.
.15441 litres.

WEIGHT OF WATER.

1 cu. ft. water at 70° F. weighs 62.3 lbs.
at 60° F. " 62.363 lbs.
1 cu. ft. water contains 7.4805 liquid gals.
1 gal. water weighs 8.33 lbs.

HEAD AND PRESSURE OF WATER (Neglecting Friction).

(At 60° F.)

Head in feet = lbs. per sq. inch × 2.309.
= lbs. " " ft. × .016035.
Pressure in lbs. per sq. inch = head in ft. × .433.
" " " " " ft. = " " " × 62.363.

HEAD REQUIRED TO OVERCOME FRICTION IN STRAIGHT PIPES.

$$H = \left(K \times \frac{l}{d} + 1.5\right) \times \frac{v^2}{2g}.$$

K = constant. (See p. 88.)
l = length pipe in feet.
d = diameter pipe in feet.
1.5 = coefficient to allow for loss entering pipe.
v = velocity of flow in feet per second.
g = force of gravity.

VALUES OF K FOR VARIOUS VELOCITIES.

Foot per Second.	*K.*	Foot per Second.	*K.*
1	.0317	9	.0202
2	.0266	10	.0199
3	.0244	11	.0196
4	.0231	12	.0194
5	.0221	13	.0191
6	.0215	14	.0189
7	.0209	15	.0188
8	.0205	16	.0187

APPROXIMATE FORMULA FOR VELOCITY OF WATER IN STRAIGHT, SMOOTH, CYLINDRICAL IRON PIPES.

Velocity in ft. per sec.

$$= K\sqrt{\frac{\text{diam. in ft.} \times \text{head in ft.}}{\text{length pipe in ft.} + 54 \text{ diams. in ft.}}}.$$

VALUE OF COEFFICIENT K (Deduced from Experiments).

$\sqrt{\frac{\text{diam.} \times \text{head}}{\text{length} + 54 \text{ diam.}}}$	Diameter of Pipe in Feet.							
	.05	.1	.5	1.	1.5	2	3	4
	K.							
.005	29	31	33	35	37	40	44	47
.01	34	35	37	39	42	45	49	53
.02	39	40	42	45	49	52	56	59
.03	41	43	47	50	54	57	60	63
.05	44	47	52	54	56	60	64	67
.1	47	50	54	56	58	62	66	70
.2 and over.	48	51	55	58	60	64	67	70

MINER'S INCH.

A "Miner's Inch" is a measure of the flow of water through an opening one inch square in a plank two inches thick under a head of six inches of water to upper edge of opening.

Discharge per minute = 11.625 liquid gal.
" " " = 1.554 cu. ft.
Inches per H.P. under 100′ head = 3.408 .
H.P. per inch " " " = .293.

DATA FOR LIQUID RHEOSTATS.

(Experimental.)

Resistance of ordinary hydrant water per square foot cross-section and foot in length, approximately, 100 ohms.

RESISTANCE WHEN DILUTED WITH COMMERCIAL TABLE-SALT.

% Salt.	Resistance in Ohms.
.23	7.84
.46	4.65
.70	3.12
.93	2.38
1.16	1.9
1.39	1.48

% salt *by weight.*

RESISTANCE WHEN DILUTED WITH COMMERCIAL OIL OF VITRIOL.

% Acid.	Resistance in Ohms.
.174	4.12
.435	1.75
.724	1.10
.985	.85

LOGARITHMS OF NUMBERS TO 1000.

N	0	1	2	3	4	5	6	7	8	9	D.
10	000000	4321	8600	012837	17033	21189	25306	29384	033424	37426	416
11	041393	45323	49218	53078	56905	60698	64458	68186	71882	75547	380
12	079181	82785	86360	89905	93422	96910	100371	103804	107210	110590	349
13	113943	117271	120574	123852	127105	130334	133539	136721	139879	143015	323
14	146128	149219	152288	155336	158362	161368	164353	167317	170262	173186	301
15	176091	178977	181844	184691	187521	190332	193125	195900	198657	201397	281
16	204120	206826	209515	212188	214844	217484	220108	222716	225309	227887	264
17	230449	232996	235528	238046	240549	243038	245513	247973	250420	252853	249
18	255273	257679	260071	262451	264818	267172	269513	271842	274158	276462	235
19	278754	281033	283301	285557	287802	290035	292256	294466	296665	298853	223
20	301030	303196	305351	307496	309630	311754	313867	315970	318063	320146	212
21	322219	324282	326336	328380	330414	332438	334454	336460	338456	340444	202
22	342423	344392	346353	348305	350248	352183	354108	356026	357935	359835	193
23	361728	363612	365488	367356	369216	371068	372912	374748	376577	378398	185
24	380211	382017	383815	385606	387390	389166	390935	392697	394452	396199	178
25	397940	399674	401401	403121	404834	406540	408240	409933	411620	413300	174
26	414973	416641	418301	419956	421604	423246	424882	426511	428135	429752	164
27	431364	432969	434569	436163	437751	439333	440909	442480	444045	445604	158
28	447158	448706	450249	451786	453318	454845	456366	457882	459392	460898	153
29	462398	463893	465383	466868	468347	469822	471292	472756	474216	475671	148
30	477121	478566	480007	481443	482874	484300	485721	487138	488551	489958	143
31	491362	492760	494155	495544	496930	498311	499687	501059	502427	503791	138
32	505150	506505	507856	509203	510545	511883	513218	514548	515874	517196	134
33	518514	519828	521138	522444	523746	525045	526339	527630	528917	530200	130
34	531479	532754	534026	535294	536558	537819	539076	540329	541579	542825	126
35	544068	545307	546543	547775	549003	550228	551450	552668	553883	555094	122
36	556303	557507	558709	559907	561101	562293	563481	564666	565848	567026	119
37	568202	569374	570543	571709	572872	574031	575188	576341	577492	578639	116
38	579784	580925	582063	583199	584331	585461	586587	587711	588832	589950	113
39	591065	592177	593286	594393	595496	596597	597695	598791	599883	600973	110
40	602060	603144	604226	605305	606381	607455	608526	609594	610660	611723	107
41	612784	613842	614897	615950	617000	618048	619093	620136	621176	622214	104
42	623249	624282	625312	626340	627366	628389	629410	630428	631444	632457	102
43	633468	634477	635484	636488	637490	638489	639486	640481	641474	642465	100
44	643453	644439	645422	646404	647383	648360	649335	650308	651278	652246	98
45	653213	654177	655138	656098	657056	658011	658965	659916	660865	661813	96
46	662758	663701	664642	665581	666518	667453	668386	669317	670246	671173	94
47	672098	673021	673942	674861	675778	676694	677607	678518	679428	680336	92
48	681241	682145	683047	683947	684845	685742	686636	687529	688420	689309	90
49	690196	691081	691965	692847	693727	694605	695482	696356	697229	698101	88
50	698970	699838	700704	701568	702431	703291	704151	705008	705864	706718	86
51	707570	708421	709270	710117	710963	711807	712650	713491	714330	715167	84
52	716003	716838	717671	718502	719331	720159	720986	721811	722634	723456	83
53	724276	725095	725912	726727	727541	728354	729165	729974	730782	731589	81
54	732394	733197	733999	734800	735599	736397	737193	737987	738781	739572	80

LOGARITHMS OF NUMBERS TO 1000—*Continued*

N	0	1	2	3	4	5	6	7	8	9	D
55	740363	741152	741939	742725	743510	744293	745075	745855	746634	747412	7
56	748188	748963	749736	750508	751279	752048	752816	753583	754348	755112	7
57	755875	756636	757396	758155	758912	759668	760422	761176	761928	762679	7
58	763428	764176	764923	765669	766413	767156	767898	768638	769377	770115	7
59	770852	771587	772322	773055	773786	774517	775246	775974	776701	777427	7
60	778151	778874	779596	780317	781037	781755	782473	783189	783904	784617	72
61	785330	786041	786751	787460	788168	788875	789581	790285	790988	791691	71
62	792392	793092	793790	794488	795185	795880	796574	797268	797960	798651	70
63	799341	800029	800717	801404	802089	802774	803457	804139	804821	805501	68
64	806180	806858	807535	808211	808886	809560	810233	810904	811575	812245	67
65	812913	813581	814248	814913	815578	816241	816904	817565	818226	818885	66
66	819544	820201	820858	821514	822168	822822	823474	824126	824776	825426	65
67	826075	826723	827369	828015	828660	829304	829947	830589	831230	831870	64
68	832509	833147	833784	834421	835056	835691	836324	836957	837588	838219	63
69	838849	839478	840106	840733	841359	841985	842609	843233	843855	844477	62
70	845098	845718	846337	846955	847573	848189	848805	849419	850033	850646	62
71	851258	851870	852480	853090	853698	854306	854913	855519	856124	856729	61
72	857332	857935	858537	859138	859739	860338	860937	861534	862131	862728	60
73	863323	863917	864511	865104	865696	866287	866878	867467	868056	868644	59
74	869232	869818	870404	870989	871573	872156	872739	873321	873902	874482	58
75	875061	875640	876218	876795	877371	877947	878522	879096	879669	880242	57
76	880814	881385	881955	882525	883093	883661	884229	884795	885361	885926	57
77	886491	887054	887617	888179	888741	889302	889862	890421	890980	891537	56
78	892095	892651	893207	893762	894316	894870	895423	895975	896526	897077	55
79	897627	898176	898725	899273	899821	900367	900913	901458	902003	902547	54
80	903090	903633	904174	904716	905256	905796	906335	906874	907411	907949	54
81	908485	909021	909556	910091	910624	911158	911690	912222	912753	913284	53
82	913814	914343	914872	915400	915927	916454	916980	917506	918030	918555	53
83	919078	919601	920123	920645	921166	921686	922206	922725	923244	923762	52
84	924279	924796	925312	925828	926342	926857	927370	927883	928396	928908	51
85	929419	929930	930440	930949	931458	931966	932474	932981	933487	933993	51
86	934498	935003	935507	936011	936514	937016	937518	938019	938520	939020	50
87	939519	940018	940516	941014	941511	942008	942504	943000	943495	943989	50
88	944483	944976	945469	945961	946452	946943	947434	947924	948413	948902	49
89	949390	949878	950365	950851	951338	951823	952308	952792	953276	953760	49
90	954243	954725	955207	955688	956168	956649	957128	957607	958086	958564	48
91	959041	959518	959995	960471	960946	961421	961895	962369	962843	963316	48
92	963788	964260	964731	965202	965672	966142	966611	967080	967548	968016	47
93	968483	968950	969416	969882	970347	970812	971276	971740	972203	972666	46
94	973128	973590	974051	974512	974972	975432	975891	976350	976808	977266	46
95	977724	978181	978637	979093	979548	980003	980458	980912	981366	981819	46
96	982271	982723	983175	983626	984077	984527	984977	985426	985875	986324	45
97	986772	987219	987666	988113	988559	989005	989450	989895	990339	990783	45
98	991226	991669	992111	992554	992995	993436	993877	994317	994757	995196	44
99	995635	996074	996512	996949	997386	997823	998259	998695	999131	999565	44

INDEX.

PAGE

A

Arcs, circular, length of, with radius 1........ 34
Areas of circles, diameters in units and eighths....... 64
" " feet and inches......... 75

B

Bricks, dimensions of.................................. 15
lining of stacks........... 14
Brickwork in foundations and walls.................. 15

C

Cars, approximate dimensions of, motor............. 16
" " " trail................ 17
Chimneys, brick lining for 14
height and draught power..... 12
sizes with appropriate H. P. boilers........ 13
weight of iron or steel.... 14
Circumferences, diameters in units and eighths....... 64
" " feet and inches...... ... 75
Coals, American... 11
Conductivity of copper wire...... ....24, 25
steel rails.............................. 31
Cubes and cube roots.............. 39
Cuts and fills.... 37
Cylinders, capacity of. 87

D

Decimals, feet expressed in decimals of a mile. 80
inches " " " " foot........ .. 81
of an inch for each 1-64...................... 80

INDEX.

PAGE

Dip, in span wire 22
  " trolley " 23

E

Earths, average weight 38
  natural slope 36
  shrinkage in embankment 38
Elevation, of outside rail 35
Embankment, increase of stone in 38
  shrinkage of earth in 38
Evaporation, factors of 6
Excavation, cuts and fills 37
  for track 36

F

Factors, of evaporation 6
Feed-water, saving of fuel by heating 5
Fills and cuts 87
Foundations, brickwork in 15
Fractions. See Decimals.
Friction, head to overcome friction of water in pipes.. 87

H

Head, and pressure of water 87
  required to overcome friction in pipes 87
Headway, of cars 19
Heat, table of loss of heat from steam-pipes 10
Horse-power, per ton and per mile with various grades and coefficients 20
Horse-power and torque 18
Hyperbolic logarithms 1

I

Inch, miner's 88
Iron, weight per square foot rolled 14
  and steel wire, weights of 27

INDEX.

PAGE

J

Joints, per 1000 ft. and per mile........................ 29

L

Length, measures of........ 84
Liquid rheostat.. 89
Logarithms, hyperbolic..................... 1
  of numbers................................ 90

M

Measures, board................. 85
  of length.............................. ... 84
  of pressure.................................. 86
  of surface 84
Middle ordinates, for chords of 100 ft.................. 33
  " " " 10 ft.................... 33
  and chords for arc of 30 ft........... 34
Miner's inch...................... 88
Motor cars, approximate dimensions.................. 16

P

Paving.. 36
Perch.......................... 86
Poles, cubic contents, wooden.......................... 21
  dimensions of wrought-iron and steel........... 21
  strain on.. 22
Pressure, measures of.................................. 86
  mean pressure ratios 4
  terminal pressure " 5
  of water...................................... 87

R

Rails, elevation of outside............................ 35
  weights.............................. 30
Ratios, mean pressure................................. 1
  terminal " 5
Reciprocals, of numbers................................ 39

PAGE
Resistance, of copper wire 24, 25
 standard adopted by A. I. E. E............ 26
Rheostat, liquid.. 89

S

Shafts, H. P., iron and steel............................ 15
Shrinkage, of earth in embankments................ 38
Silicon bronze, breaking weight of..................... 26
 weight of............................. 27
Slope, natural slope of earths........................ 36
Span wire, dip in 22
 weight and tensile strength of............... 28
Speed, headway and total cars......................... 19
 miles per hour in feet per minute and per second.. 19
Spikes, per 1000 ft. and per mile...................... 29
 size and weight.................................. 29
Squares, and square roots.............................. 39
Stacks. See Chimneys.
Steam, properties of saturated......................... 8
 pipes, table of loss of heat from............... 10
Steel, conductivity of, in rails.......................... 31
Stone, increase of, in embankment.................... 38
 weight.. 38
Strain, on poles.. 22
 " span wire....................................... 22
 " trolley " 23
Surface, measures of...................................... 84

T

Tables, of copper wire...................................24, 25
 loss of heat from steam-pipes.................. 10
Tensile strength, copper wire.......................... 26
 E. B. B. galvanized telegraph wire.. 28
 galvanized signal strand............ 28
 silicon bronze wire.................... 26

INDEX.

PAGE
Ties, per 1000 ft. and per mile.......................... 32
sizes, board feet, cubic feet, bearing surface..... 32
Torque, and horse-power....... 18
Traction.............. 20
Trail cars, approximate dimensions.................... 17
Trolley wire, dip in.................................... 23
strain on..................... 23
Trucks, approximate weights. 18
revolutions of wheels per minute at one mile per hour..................................... 18

V

Velocity, formula for velocity of water in pipes....... 88

W

Walls, brickwork in.................................... 15
Water, weight of....................................... 87
Weights, copper wire............. 24-25-27
E. B. B. galvanized telegraph wire.......... 28
earth and rocks........ 38
galvanized signal strand...................... 28
iron and steel wire............................ 27
rails.. 30
rolled iron............... 14
water.................................. 87
Wheels, revolutions per minute at one mile per hour.. 18
Wire, tables of copper 24, 25
" " iron.................................27, 28
" " span........ 28
Woods, American....................................... 12
average weights.... 21

IF YOU WISH TO KNOW

The latest and best work or works on the principles and theory of Electricity, or relating to any particular application of Electricity, THE ELECTRICAL WORLD will be pleased to promptly furnish the information, personally or by letter, free of charge. If you live in or near New York, and would like to examine any Electrical Books, you are cordially invited to visit the office of THE ELECTRICAL WORLD and look them over at your leisure.

Making a specialty of Electrical Books, there is no work relating directly or indirectly to Electricity that is not either published or for sale by The Johnston Company, and the manager of the Book Department keeps himself at all times familiar with the contents of every work issued on this subject at home and abroad.

Any Electrical Book in this catalogue, or any Electrical Book published, American or foreign, will be mailed to ANY ADDRESS in the world, POSTAGE PREPAID, on receipt of price. Address and make drafts, P. O. orders, etc., payable to

The W. J. JOHNSTON COMPANY, Ltd.,

TIMES BUILDING, NEW YORK.

PUBLICATIONS OF

THE W. J. JOHNSTON COMPANY, Ltd.

The Electrical World. An Illustrated Weekly Review of Current Progress in Electricity and its Practical Application. Annual subscription......	$3.00
Johnston's Electrical and Street Railway Directory. Published annually..............	5.00
The Telegraph in America. By JAS. D. REID. 894 royal octavo pages, illustrated. Russia.......	7.00
Dictionary of Electrical Words, Terms and Phrases. By E. J. HOUSTON, A.M. Second Edition. 562 double-column octavo pages, 570 illus...	5.00
The Electric Motor and its Applications. By T. C. MARTIN and JOS. WETZLER. With an appendix on the Development of the Electric Motor since 1888, by Dr. LOUIS BELL. 315 pages, 353 illustrations.	3.00
The Electric Railway in Theory and Practice. By O. T. CROSBY and Dr. LOUIS BELL. Second edition. 416 pages, 182 illustrations............ ...	2.50
Alternating Currents. An Analytical and Graphical Treatment for Students and Engineers. By F. BEDELL, Ph.D. and A. C. CREHORE, Ph.D. Second edition. 325 pages, 112 illustrations.......	2.50
Principles of Dynamo-Electric Machines and Practical Directions for Designing and Constructing Dynamos. By CARL HERING. Seventh thousand. 279 pages, 59 illustrations....	2.50
Continuous-Current Dynamos and Motors. An Elementary Treatise for Students. By FRANK P. COX, B.S. 271 pages, 83 illustrations...........	2.00
Electric-Lighting Specifications for the Use of Engineers and Architects. By E. A. MERRILL. 175 pages..................	1.50
The Quadruplex. By WM. MAVER, Jr., and MINOR M. DAVIS. With Chapters on the Dynamo in Relation to the Quadruplex, the Wheatstone Automatic Telegraph, etc. 126 pages, 63 illustrations..	1.50
The Elements of Static Electricity, with Full Descriptions of the Holtz and Topler Machines. By PHILIP ATKINSON, Ph.D. 228 pages, 64 illus........	1.50
Lightning Flashes. A Volume of Short, Bright and Crisp Electrical Stories and Sketches. 160 pages, copiously illustrated....	1.50
A Practical Treatise on Lightning Protection. By H. W. SPANG. 180 pages, 28 illustrations.	1.50
A Practical Treatise on Lightning Conduc- -s. By H. W. SPANG. 48 pages, 10 illus........	.75

Electricity and Magnetism. Being a Series of Advanced Primers. By E. J. HOUSTON, A.M. 306 pages, 116 illustrations	$1.00
Electrical Measurements, and Other Advanced Primers of Electricity. By E. J. HOUSTON, A.M. 429 pages, 169 illustrations	1.00
The Electrical Transmission of Intelligence, and Other Advanced Primers of Electricity. By E. J. HOUSTON, A.M. 330 pages, 88 illus.	1.00
Alternating Currents of Electricity. Their Generation, Measurement, Distribution and Application. By GISBERT KAPP. 166 pages, 38 illus.	1.00
Recent Progress in Electric Railways. Being a Summary of Current Advance in Electric Railway Construction, Operation, Appliances, etc. Compiled by CARL HERING. 386 pages, 120 illus.	1.00
Reference Book of Tables and Formulæ for Electric Street Railway Engineers. By E. MERRILL	1.00
Original Papers on Dynamo Machinery and Allied Subjects. By JOHN HOPKINSON, F.R.S. 249 pages, 90 illustrations	1.00
Universal Wiring Computer for Determining the Sizes of Wires for Incandescent Electric-Lamp Leads without Calculation, with Some Notes on Wiring, etc. By CARL HERING. 44 pages	1.00
Dynamo and Motor Building for Amateurs. With Working Drawings. By C. D. PARKHURST	1.00
Experiments with Alternating Currents of High Potential and High Frequency. By NIKOLA TESLA. 146 pages, 30 illustrations	1.00
Lectures on the Electromagnet. By Prof. SILVANUS P. THOMPSON. 287 pages, 75 illustrations.	1.00
Electricity at the Paris Exposition of 1889. By CARL HERING. 250 pages, 62 illustrations	2.00
Practical Information for Telephonists. By T. D. LOCKWOOD. 192 pages	1.00
Wheeler's Chart of Wire Gauges	1.00
Davis' Standard Tables for Electric Wiremen	1.00
Proceedings of the National Conference of Electricians. 300 pages, 23 illustrations	.75
Wired Love: A Romance of Dots and Dashes. 256 pages	.75
Tables of Equivalents of Units of Measurement. By CARL HERING	.50

THE W. J. JOHNSTON COMPANY, Ltd.,
41 Park Row (Times Building), New York

SECOND EDITION, JUST ISSUED.

Revised. Enlarged. Entirely Rewritten.

A Dictionary of ELECTRICAL WORDS, TERMS AND PHRASES.

By EDWIN J. HOUSTON, A.M.

562 Large Octavo Pages. 570 Illustrations. Price, $5.00.

Some idea of the scope of this timely and important work, and of the immense amount of labor involved in it, may be formed when it is stated that it contains definitions of about 5,000 DISTINCT WORDS, TERMS OR PHRASES.

The Dictionary is not a mere word book. The words, terms and phrases are invariably followed by a short, concise definition, giving the sense in which they are correctly employed and a general statement of the principles of electrical science on which the definition is founded.

As one feature, an elaborate system of cross references has been adopted, so that it is as easy to find the definitions as the words, and aliases are readily detected and traced.

The typography is excellent, being large and bold, and so arranged that each word catches the eye at a glance by standing out in sharp relief from the page.

Published and for sale, at wholesale and retail, by

W. J. JOHNSTON COMPANY, Ltd.,
TIMES BUILDING, NEW YORK.

ELECTRICITY AND MAGNETISM:

A Series of Advanced Primers.

By Prof. EDWIN J. HOUSTON,

AUTHOR OF

A Dictionary of Electrical Words, Terms and Phrases.

Cloth. 306 Pages, 116 Illustrations. Price, $1.00.

Prof. Houston's Primers of Electricity written in 1884 enjoyed a wide circulation, not only in the United States but in Europe, and for some time have been out of print. Owing to the great progress in electricity since that date the author has been led to prepare an entirely new series of primers, but of a more advanced character in consonance with the advanced general knowledge of electricity.

Electricians will find these primers of marked interest from their lucid explanations of principles, and the general public will in them find an easily read and agreeable introduction to a fascinating subject.

CONTENTS.

I.—Effects of Electric Charge. II.—Insulators and Conductors. III.—Effects of an Electric Discharge. IV.—Electric Sources. V.—Electro-receptive Devices. VI.—Electric Current. VII.—Electric Units. VIII.—Electric Work and Power. IX.—Varieties of Electric Circuits. X.—Magnetism. XI.—Magnetic Induction. XII.—Theories of Magnetism. XIII.—Phenomena of the Earth's Magnetism. XIV.—Electro-Magnets. XV.—Electrostatic Induction. XVI.—Frictional and Influence Machines. XVII.—Atmospheric Electricity. XVIII.—Voltaic Cells. XIX.—Review, Primer of Primers.

Published and for sale, at wholesale and retail, by

The W. J. JOHNSTON COMPANY, Ltd

TIMES BUILDING, NEW YORK.

The Measurement of Electrical Currents

And Other Advanced Primers of Electricity.

By Prof. EDWIN J. HOUSTON, A.M.,

AUTHOR OF

"*A Dictionary of Electrical Words, Terms, and Phrases,*" "*Electricity and Magnetism,*
" *Electricity a Hundred Years Ago,*"
etc., etc.

Cloth. 320 Pages. 120 Illustrations. Price $1.00.

This volume is the second of Professor Houston's admirable series of Advanced Primers of Electricity, and is devoted to the measurement and practical applications of the electric current.

Marked features of these books are the logical and lucid development of principles in language easily followed with no previous knowledge of electricity, and the abstracts from standard electrical authors at the end of each Primer, which in general have reference, and furnish an extension, to some point in the Primer, and at the same time give the reader an introduction to electrical literature.

CONTENTS.

I. The Measurement of Electric Currents.—II. The Measurement of Electromotive Force.—III. The Measurement of Electric Resistances.—IV. Voltaic Cells.—V. Thermo-Electric Cells and other Electric Sources.—VI. The Distribution of Electricity by Constant Currents.—VII. Arc Lighting.—VIII. Incandescent Electric Lighting.—IX. Alternating Currents.—X. Alternating Current Distribution.—XI. Electric Currents of High Frequency.—XII. Electro-Dynamic Induction.—XIII. Induction Coils and Transformers.—XIV. Dynamo-Electric Machines.—XV. Electro-Dynamics.—XVI. The Electro-Motor.—XVII. The Electric Transmission of Power.—XVIII. Review: Primer of Primers.

THE W. J. JOHNSTON COMPANY, Ltd.,

TIMES BUILDING, NEW YORK.

THE

ELECTRICAL TRANSMISSION OF INTELLIGENCE

And Other Advanced Primers of Electricity.

By Prof. EDWIN J. HOUSTON, A.M.,

Author of "A Dictionary of Electrical Words, Terms, and Phrases," etc., etc., etc.

Cloth. Price $1.00.

The third and concluding volume of Prof. Houston's Series of Advanced Primers of Electricity is devoted to the telegraph, telephone, and miscellaneous applications of the electric current.

In this volume the difficult subjects of multiple and cable telegraphy and electrolysis, as well as the telephone, storage battery, etc., are treated in a manner that enables the beginner to easily grasp the principles, and yet with no sacrifice in completeness of presentation.

CONTENTS.

I. The Electric Transmission of Intelligence.—II. The Electric Telegraph.—III. Multiple Telegraphy.—IV. Cable Telegraphy.—V. Electric Annunciators and Alarms.—VI. Time Telegraphy.—VII. The Telephone.—VIII. Electroysis.—IX. Electro-Metallurgy.—X. Storage or Secondary Batteries.—XI. Electricity in Warfare; Electric Welding.—XII. Some Other Applications of Electricity.—XIII. Electro-Therapeutics.—XIV. Review: Primer of Primers.

Published and for Sale by

THE W. J. JOHNSTON COMPANY, Ltd.,

TIMES BUILDING, NEW YORK.

JUST PUBLISHED.

THE ELECTRIC RAILWAY

In Theory and Practice.

By O. T. CROSBY and Dr. LOUIS BELL.

400 Octavo Pages. 179 Illustrations. Price, $2.50.

This is the first **Systematic Treatise** *that has been published on the* **Electric Railway,** *and it is intended to cover the* **General Principles of Design, Construction and Operation.**

TABLE OF CONTENTS.

Chapter I. General Electrical Theory.
" II. Prime Movers.
" III. Motors and Car Equipment.
" IV. The Line.
" V. Track, Car Houses, Snow Machines.
" VI. The Station.
" VII. The Efficiency of Electric Traction.
" VIII. Storage Battery Traction.
" IX. Miscellaneous Methods of Electric Traction.
" X. High Speed Service.
" XI. Commercial Considerations.
" XII. Historical Notes.

APPENDICES.

Appendix A. Electric Railway vs. Telephone Decisions.
" B. Instructions to Linemen.
" C. Engineer's Log Book.
" D. Classification of Expenditures of Electric Street Railways.
" E. Concerning Lightning Protection, by Prof. Elihu Thomson.

Published and for sale, at wholesale and retail, by

W. J. JOHNSTON COMPANY, Ltd.,
TIMES BUILDING, NEW YORK.

RECENT PROGRESS
IN
ELECTRIC RAILWAYS:

BEING A SUMMARY OF CURRENT PROGRESS IN ELECTRIC RAILWAY CONSTRUCTION, OPERATION, SYSTEMS, MACHINERY, APPLIANCES, ETC.

COMPILED BY

CARL HERING.

886 Pages and 120 Illustrations. Cloth. Price, $1.00.

This volume contains a classified summary of the recent literature on this active and promising branch of electrical progress, with descriptions of new apparatus and devices of general interest.

CONTENTS.

Chapter I.—Historical. Chapter II.—Development and Statistics. Chapter III.—Construction and Operation. Chapter IV.—Cost of Construction and Operation. Chapter V.—Overhead Wire Surface Roads. Chapter VI.—Conduit and Surface Conductor Roads. Chapter VII.—Storage Battery Roads. Chapter VIII. — Underground Tunnel Roads. Chapter IX.—High Speed Interurban Railroads Chapter X.—Miscellaneous Systems. Chapter XI.—Generators, Motors and Trucks. Chapter XII.—Accessories.

Mailed prepaid to any address on receipt of the price by the Publishers,

The W. J. JOHNSTON COMPANY, L

TIMES BUILDING, NEW YORK.

Continuous Current Dynamos & Motors.

Their Theory, Design, and Testing.

WITH SECTIONS ON INDICATOR DIAGRAMS, PROPERTIES OF SATURATED STEAM, BELTING CALCULATIONS, ETC.

AN ELEMENTARY TREATISE FOR STUDENTS.

By FRANK P. COX, B.S.

Cloth. 271 Pages. 83 Illustrations. Price $2.00.

The purpose of this work is to present to students of electro-technics in a simple and direct manner, without the use of higher mathematics, the theory, design, and testing of continuous-current dynamos and motors as understood and carried out in commercial practice.

A valuable feature of the work is the application t numerical problems of the principles developed, th problems being so selected as to cover as broad a field a possible and to show how to make the various compromise always found necessary in practical designing.

Owing to the steam-engine being so closely allied t the testing and operation of dynamos and motors, section on indicator-diagrams, steam-power calculations, an belting are included.

CONTENTS.

CHAPTER I. The Absolute System of Measurement - II. Electro-Magnetic Induction.—III. Classification o Machines and General Principles of the Magnetic Circui —IV. The Dynamo as a Motor.—V. Calculations pertainin to the Magnetic Circuit.—VI. Theory of Windings, Losse etc.—VII. The Dynamo considered as a Motor.—VII Design of Armatures.—IX. Design of Field Magnet —X. Design of Motors.—XI. Dynamo and Motor Testin —XII. Efficiency Tests.—XIII. Indicator Diagrams.—XI Steam-engine Calculations.—APPENDIX I. Tests of Iro —II. Ampere-turn Tables.—III. Determination of Sizes Wire for Armatures and Field Coils.—IV. Belting.

THE W. J. JOHNSTON COMPANY, Ltd

41 PARK ROW, NEW YORK.

Dynamo and Motor Building

FOR AMATEURS.

WITH WORKING DRAWINGS.

BY

LIEUT. C. D. PARKHURST, U. S. A.

Cloth. 163 Pages. 71 Illustrations. Price $1.00.

Descriptions and working drawings are given of the ollowing dynamos and motors:

A small ventilating fan motor.—A sewing machine attery motor, requiring no patterns or castings in its con- ruction.—A sewing machine motor of more finished pearance and greater efficiency than the above.—A 50- ght incandescent dynamo.

A chapter treats of armature windings, connections d currents, giving minute instructions illustrated with tailed drawings. In the chapter on the 50-light dynamo e various technical points involved in dynamo design e fully and clearly treated, enabling the amateur to sign other forms of machines than those described, in hich he will be assisted by an appendix giving data of a mber of high class motors and dynamos of standard anufacture.

Copies of this or any other electrical book or books pub- hed will be promptly mailed to any address in the world, STAGE PREPAID, *on receipt of price. Address*

HE W. J. JOHNSTON COMPANY, Ltd.,

41 PARK ROW, NEW YORK.

ELECTRIC LIGHTING

SPECIFICATIONS

FOR THE USE OF

Engineers and Architects.

By E. A. MERRILL.

Cloth. 176 Pages. Price, including Postage, $1.50.

The author has drawn up a set of specifications covering the various classes of lighting installations, which will serve as forms for any special type or character of plant, and which are at the same time full enough to cover the ordinary installation of electrical apparatus and electric light wiring. The book will prove especially useful to architects and engineers who desire a full knowledge of the necessary requirements of the various classes of electrical installations in order to meet the demands of the insurance inspectors and the conditions of safety. The latest rules are given of the (1) National Electric Light Association, (2) National Board of Fire Underwriters, (3) New England Insurance Exchange.

Mailed prepaid to any address on receipt of the price by the Publishers,

The W. J. JOHNSTON COMPANY, Ltd.,

TIMES BUILDING, NEW YORK.

FOURTH EDITION.

STANDARD TABLES

FOR

ELECTRIC WIREMEN,

WITH INSTRUCTIONS FOR WIREMEN AND LINEMEN, UNDERWRITERS' RULES, AND USEFUL FORMULÆ AND DATA.

By CHAS. M. DAVIS.

Fourth Edition, Thoroughly Revised and Edited by

W. D. WEAVER.

Flexible Morocco.* *128 Pages.* *Price $1.00.

The Fourth Edition of this popular book contains the latest revisions of the insurance rules of the Underwriters' International Electric Association, now almost exclusively used in the United States. An important section has been added on the calculation of alternating current wiring, which, for the first time, brings this subject within the reach of practical men.

A number of the most important tables were prepared expressly for this work, and being copyrighted, cannot be found elsewhere. All the wiring tables are calculated on a uniform basis and arranged in the most convenient manner for practical use.

The object always kept in view has been to produce a book for wiremen and electricians of a thoroughly practical character and free from the padding and useless tables that generally accompany such works.

Copies of this or any other electrical book or books published will be promptly mailed to any address in the world, POSTAGE PREPAID, *on receipt of price. Address*

THE W. J. JOHNSTON COMPANY, Ltd.,

41 PARK ROW, NEW YORK.

THE

UNIVERSAL WIRING COMPUTER.

By CARL HERING,

Author of "Principles of Dynamo-Electric Machines," "Magnet Winding," etc.

Convenient Size for the Pocket. Cloth. Price, $1.00.

Gives the sizes of wires directly in circular mils or in gauge numbers, *for any make of lamp* (or any horse power of current), *for any loss*, *for any number of lamps*, and *at any distances*, *without calculations, formulæ or knowledge of mathematics.*

It is the equivalent of a complete set of tables for all practical cases, with the advantage over these of being much simpler, more compact and handy than such a cumbersome and bulky set of tables would be. It gives the result in as little time as it would otherwise take to write down the figures to perform the calculation.

The book includes also an illustrated article giving general hints on wiring and a set of original *Useful Auxiliary Tables*, such as for heating limits, weights of insulation, power reductions, composite wires of large sections, weights and resistances, wire gauges, etc.

Mailed postpaid to any address on receipt of the price by the Publishers.

The W. J. JOHNSTON COMPANY, Ltd.,
TIMES BUILDING, NEW YORK.

NEW EDITION.—REVISED AND ENLARGED.

JOHNSTON'S
Electrical and Street Railway
DIRECTORY.

CONTAINING LISTS OF

Central Electric Light Stations, Isolated Plants, Electric Mining Plants, Street Railway Companies (Electric, Horse and Cable), with detailed Information regarding each.

ALSO LISTS OF

Manufacturers of, and Dealers in, Electrical and Street Railway Apparatus; Electricians, etc.

PUBLISHED ANNUALLY.
SUBSTANTIALLY BOUND IN CLOTH, PRICE $5.00.

The great facilities possessed by THE ELECTRICAL WORLD for obtaining information in every branch covered by the Directory, added to the special facilities of the Directory Department itself, guarantee that the work will ALWAYS be the MOST COMPLETE, the MOST RELIABLE and the MOST VALUABLE of any work of the kind EVER ISSUED.

THE W. J. JOHNSTON COMPANY, Ltd
41 PARK ROW, NEW YORK.

The Pioneer Electrical Journal of America.

READ WHEREVER THE ENGLISH LANGUAGE IS SPOKEN.

The Electrical World

IS THE

Largest, Most Handsomely Illustrated, and Widest Circulated Electrical Journal in the World.

It should be read not only by every ambitious electrician anxious to rise in his profession, but by every intelligent American.

The paper is ably edited and noted for explaining electrical principles and describing new inventions and discoveries in simple and easy language, devoid of technicalities. It also gives promptly the most complete news from all parts of the world, relating to the different applications of electricity.

Subscription, including Postage in the U. S., Canada, or Mexico, $3.00 a Year.

May be ordered of any Newsdealer at 10 cents a week.

The W. J. JOHNSTON COMPANY, Ltd.

TIMES BUILDING, NEW YORK.

This book should be returned to the Library on or before the last date stamped below.

A fine of five cents a day is incurred by retaining it beyond the specified time.

Please return promptly.

Eng 868.94
Reference book of tables and formul
Cabot Science 006026110

3 2044 092 011 949